RADIO and ELECTRONICS

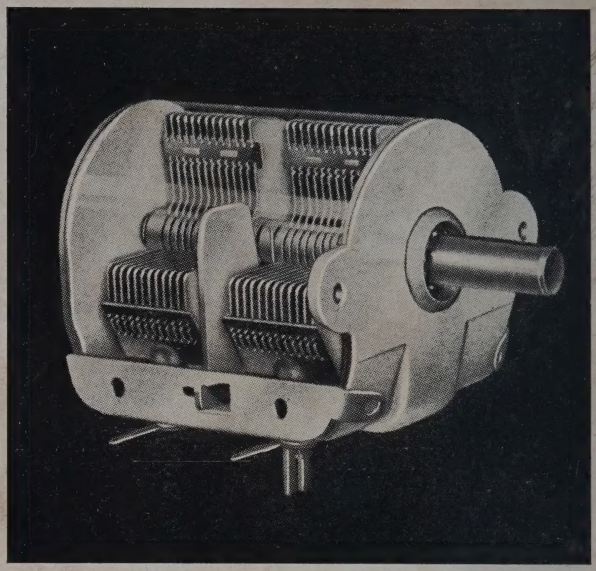
ELECTRICITY — COMMUNICATIONS — SERVICE — SOUND

MARCH 1, 1951 VOL. 6, NO. 1

1/10

Plessey

"R" TYPE GANG CONDENSERS



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Part Nos.	Capacity		Vanes per Section		Air Gap	Weight (oz.)	Weight (grams)
	Swing (pF)	Min. (max.) (pF)	Rotor	Stator			
CP68832R/11 2-Gang	370	13	13	12	0.009 in.	5.25	150
CP68833R/3 3-Gang	370	13	13	12	0.009 in.	7.25	200

STANDARD SPECIFICATION

FRAME: The frame is built up in steel, finished cadmium plate. The fixing holes are positioned as indicated on the dimensional sketch.

VANES: The rotor and stator vanes are made from finest quality aluminium.

ROTOR SPINDLE: The rotor spindle is made from brass and has a smooth finish. The standard spindle length is $\frac{3}{4}$ in.

CAPACITY SWING: Standard "R" type Variable Condensers are only available in the capacity swing of 370 pF. increasing clockwise.

CONTACT FORKS are of silver-plated brass wire.

BEARINGS: The spindle is mounted on ball-bearings. The bearings are packed with a medium viscosity heavy grease, thus ensuring a mechanical smoothness in operation. Alternative lubrication can be arranged for any special conditions.

INSULATION: The stators are mounted on low loss ceramic pillars.

MOUNTINGS: No mounting brackets are normally necessary.

DUST-PROOF COVER: The dust-proof cover completely encloses the rotor and stator vanes and is of transparent synthetic plastic.

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OUR COVER

A view of the modern three-valve regenerative short-wave set described in this issue.

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The Importance of Television

In a recent press interview, Mr. C. O. Stanley, chairman of directors of a large British television manufacturing firm, had some very interesting remarks to make on some of the aspects of television that seem to have escaped consideration here. At the moment, the Government is no doubt deliberating whether, in view of the international situation, it would be wise to expend money and effort in establishing a television service. Except for the fact that the Minister of Broadcasting has expressed himself as being very much in favour of the early introduction of television, other things being equal, nothing is known of the Government's intentions, but it is only natural to assume that the recent rapid deterioration in world relations must have had an effect on whatever views the Government may hold. The question will now be one, not of estimating the desirability or otherwise of our taking a practical interest in the newest and most potent means of home entertainment and education, but of considering whether every effort of which we are capable will not soon be needed for more urgent purposes. In this connection, some of Mr. Stanley's remarks are worth more than passing consideration by the powers that be.

It has been estimated, said Mr. Stanley, that a third world war would require electronic equipment to be manufactured and used on a scale fourteen times greater than during the last war. He did not say by whom this estimate was made, but it is not unreasonable to suppose that a man in Mr. Stanley's position should be close enough to official quarters for such a statement to have been made with "inside" knowledge.

Those of us who had some opportunity to observe the vast use to which electronic equipment was put during the last war will realize just what this statement signifies. Surely even the combined capacity of Britain and America will be hard put to it to produce equipment on such a colossal scale, and if this is so, then not even the relatively smaller manufacturing capacity of Australia and New Zealand will be of negligible importance. In both countries, however, the radio industry is, in the main, concerned with the production of domestic radio receivers, and there is a vast difference between the knowledge and technique required for this job and that needed for making highly specialized war equipment. Considered in this light, television assumes a new importance. It is a fact that only the possession of a flourishing television industry enabled Britain, during the last war, to put radar out of the laboratories and into the field, with a speed great enough to be of practical assistance, first to the defence of the country, and later to the highly successful offensive operations that were made possible only by electronic means.

It may not at first be apparent just why the television industry was such a telling factor. There were two main reasons. The techniques which distinguish television engineering from "ordinary" radio work are exactly those which similarly differentiate radar and most other of the war-time electronic developments. Thus, a large section of the British radio industry was able, through its knowledge of television practice, to turn this to immediate practical account in switching over to radar manufacturing. It was even possible, by a lucky chance (aided by some thoughtful planning) to make direct use of a large amount of equipment that had actually been designed for TV receivers, thereby short-circuiting a great deal of development time on one particularly important project. We do not suggest that the same thing can happen again, but there is no doubt that the second great advantage of having had television actually operating before the war was to be found in the relatively large number of men who, knowing something of TV, were able to be converted into radar engineers and technicians in a very short time. It is a noteworthy fact that many of the most notable television engineers in Britain at the time became equally famous among those in the know for their work in developing radar and other electronic projects from the stage of laboratory curiosities to being major war-winning factors. If ever Britain had a successful "secret weapon," it was her supremacy at the time in the knowledge and application of electronics. And it was this same supremracy which enabled the unparalleled manufacturing capacity of the United States to play the part it did in winning the war.

These statements, which we and many others, too, hold to be incontrovertible facts, show just how great a premium we should at this moment place on electronics. Here in New Zealand, the radio industry rose to the occasion and played a very important part, albeit a small one in producing radio equipment not only for our own forces, but for British and American ones as well. At the moment, however, we are hardly "in the swim" as far as practical knowledge of the latest electronic weapons is concerned. Nor do we have the facilities for making great contributions towards the development of new devices, but when, and if it comes to the point, we shall again be able to make a worthwhile contribution to the overall electronic war effort.

The point we wish to make here is that our usefulness will be in direct proportion to the experience we shall have gained in modern electronic technique by the time we are called upon to assist, and that by embarking on a television programme, we can do a great deal, in a strictly peaceful manner, to fit ourselves for what may be the greatest emergency ever. This point, we believe, should be given the most serious consideration by the Government when they are weighing up the pros and cons of TV in this country.

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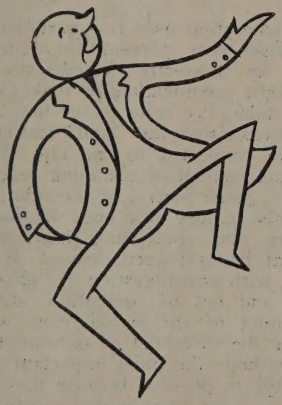

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THE SHORT-WAVE MINIATURE THREE

This little set is a living example of the fact that the regenerative T.R.F. still has its usefulness in spite of the universal popularity of the superhet for more ambitious purposes. With its modern miniature battery valves, and its miniature batteries, it represents a considerable advance on what could be done with the same basic circuit in the past, when regenerative sets were used much more than they are today.

INTRODUCTION

It has for some time been the habit of many radio enthusiasts to decry the once-popular regenerative set. Nothing less than the latest commercial communications receiver for them, they say, completely forgetting that there are many occasions when this sort of set, however superlative its performance may be, is quite useless. For example, the newcomer to radio as a hobby, whether as a constructor, or a budding "ham," often realizes that to outlay a hundred pounds or more on a commercial receiver will not teach him anything about the practical side of radio design and construction. Nor, if he is new to the game, will it do him much good to tackle the construction of a complex superhet whose principles of operation he barely understands, as yet. For him, the logical set to start off with is the regenerative. The outlay for parts and valves is not excessive, the possible faults in building and components are much smaller in number, and he has a perfectly good chance of "making it go" if it does not at first work properly. Again, once he has built such a set, it will be extremely useful to him, because in spite of the limitations of a simple receiver, it will very rarely show up to such great disadvantage that he longs for a large and lusty superhet instead. Indeed, many of us who have been in the game for a long time, and who have become quite blasé about everything except the "hottest" multi-valve receivers, have quite forgotten how well a set of this nature can perform. For low noise level and high sensitivity, together with quite adequate selectivity for all ordinary purposes, and combined with low first cost, the set that used to be described as "one of R.F., detector, and one of audio" takes quite a lot of beating, even today. And where a small, easily portable receiver is needed, as when camping, there is no kind of set which will give comparable performance for the same size and weight.

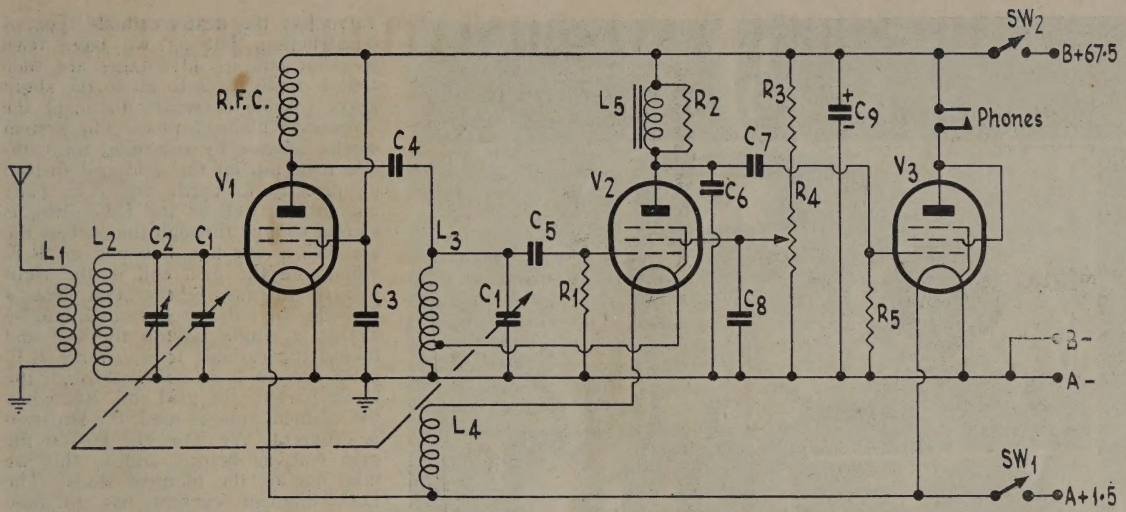
It is with these ideas in view, then, that we present this little set. It is intended for short-wave only, and covers from 3.5 to over 30 mc/sec., with three sets of plug-in coils. It uses three 1T4's, which with their diminutive size and small current drain, make an ideal line-up. Their characteristics are a great improvement compared with those of the older battery valves—30, 32, and 34—so that with modern components used throughout, it is possible to make from them a receiver which will give a much better performance, on many counts, than would the same theoretical circuit several years ago. If there are any who wish to build it as a stand-by receiver for the ham shack, for emergency use (and we think there should be many) they will be amazed at its sensitivity and at the way it can bring in the distant and weak signals. For the DX-er, who wants to carry on his hobby while away from his main receiver, or the amateur transmitter "gone mobile," we think it will fill the bill exactly, and at very small cost too.

CIRCUIT FEATURES

Perhaps the first thing to note about the circuit is that it uses the same valve type in all three positions in the set. For emergency or portable use, this is a distinct advantage, as it should be necessary to carry only one spare valve instead of possibly three. In addition, there is no loss of efficiency in so doing, since the modern sharp-cut-off pentode, as exemplified by the 1T4, is designed as a radio frequency amplifier, can act as a very reliable and sensitive detector, and can also be strapped as a triode, making an excellent audio amplifier.

The R.F. amplifier circuit is one which has never been very popular in any kind of set, but which in this application, has much to recommend it. We refer to the method of coupling from the plate of the R.F. amplifier to the grid of the detector valve. In the early days of regenerative ssets, this scheme was frowned upon because mica condensers were not all they might have been, so that leakage was able to damage the detector, and at the best to cause unwanted crackling noises in the output. Also, the older valves had rather higher interelectrode capacities than their modern counterparts, so that the direct connection of the output capacity of the R.F. valve across the detector's grid circuit had the double effect of limiting the tuning range, and, which was probably more important, of making it difficult to obtain good tracking between the R.F. and detector tuned circuits. In fact, it was almost unheard of to gang the tuning of such a set without using a panel-controlled trimmer in the aerial circuit. In this set, however, it has been found entirely practical to dispense with an aerial trimmer, and yet to have accurate tracking between the two circuits. This is done by using a preset trimmer, C_2 on the circuit diagram. This is set at the right value to make the stray capacities across the aerial circuit equal to those across the detector circuit, as a result of which the coils can be adjusted to have identical inductances, thereby keeping the circuits in tune with each other at all points on the dial, and on all coil ranges.

The method of regeneration used is a variation of one which has always been very popular for regenerative detectors employing an indirectly heated cathode, but which requires a slight modification to make it usable with a filament type tube. We refer to the use of a grid coil tapped a few turns from the "cold" end, with the cathode of the valve connected to the tap. With this arrangement, the usual method of obtaining regeneration control is to provide a panel control of the tube's screen-grid voltage, and this feature has been retained. This method of obtaining and controlling regeneration is perhaps the best that has yet been devised. It gives a very smooth control, with no suggestion of "plops" when the circuit goes in and out of oscillation, and causes practically no de-tuning of the signal, even when the detector is very near the threshold of oscillation. These two attributes are perhaps the most important ones for a regenerative detector to possess, because they make it easy to adjust the set for maximum sensitivity, and particularly easy to tune, even on weak signals. Another important advantage of the scheme is that, unlike others, it does not require widely different settings of the regeneration control at different positions of the tuning



R_1, 2 meg.
R_2, 250k. (See text).
R_3, 25k.
R_4, 50k. pot. with D.P.D.T. switch.
R_5, 10 meg.
L_1, L_2, L_3, L_4, see text.
L_5, audio transformer primary (see text).
R.F.C., 2.5 mH. R.F. choke.
V_1, V_2, V_3, 1T4.
A battery, 1.5v. type 742.
B battery, 67.5v. type 467.
C_1, midget 2-gang, 100 $\mu\mu$f. max. capacity per section.
C_2 3–30 $\mu\mu$f. trimmer.
C_3, 0.05 μf.
C_4, 50 $\mu\mu$f.
C_5, C_6, 100 $\mu\mu$f.
C_7, 0.01 μf.
C_8, 0.1 μf.
C_9, 8 μf. electrolytic.

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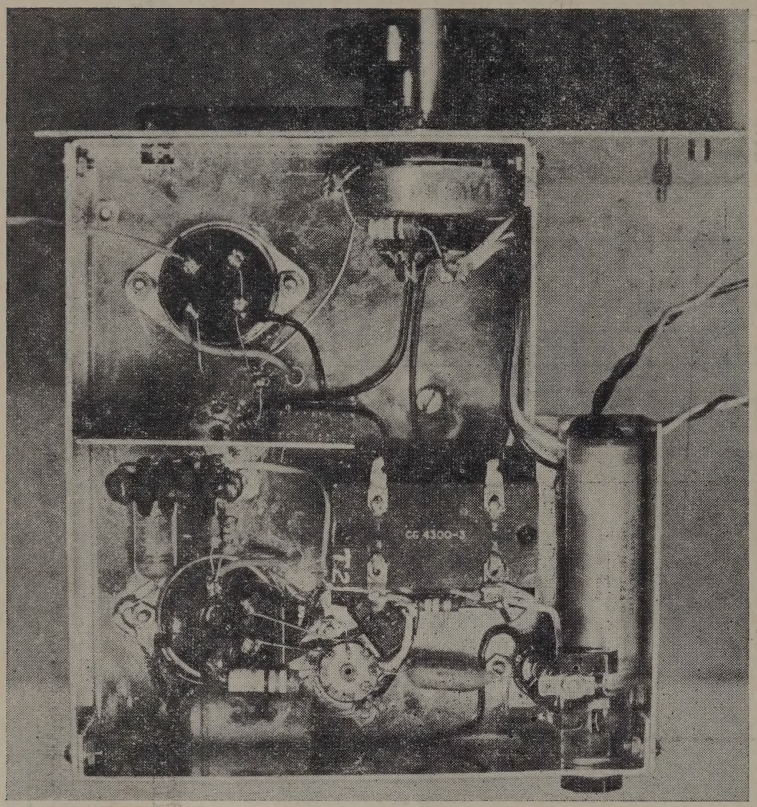


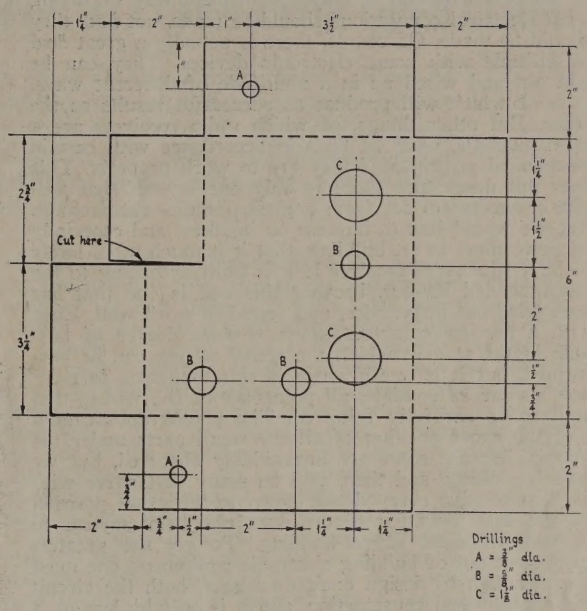
condenser; and as a by-product, the sensitivity does not vary much from one end of the wave range to the other. Those who have built many sets of this kind will remember how annoying it is to have to try and adjust a detector that plops in and out of oscillation instead of taking up smoothly and almost imperceptibly, and how, with a set that does this, one always knows that with a smooth control, the usable sensitivity would be greatly increased. Also, there is nothing more annoying than a set in which small changes in the setting of the regeneration control necessitate constant adjustment of the tuning condenser. In bad cases, a slight movement of the reaction control is often sufficient to cause the signal to disappear altogether, so that one has to start searching again in order to find it. Actually, although the regenerative set is often despised, or discounted as "elementary," there is a real art in getting the best out of a circuit when it has to be designed and built from scratch, and there are many whose objections to it really arise from the fact that they themselves have never been able to build a satisfactory one through insufficient attention to the several apparently small points, that nevertheless make quite a difference to the final performance. However, there is seldom any difficulty in duplicating the results from a well-designed regenerative set, as long as the necessary precautions, as recommended by the designer are adhered to, and those who decide to build this one need make no apologies to the scoffers, if any!

The cathode-tap-cum-screen-control method of regeneration is certainly less trouble to apply when the detector valve has the heater-cathode type of construction, but as we have tried to point out, its advantages are such that it really pays to go to the slight extra trouble necessary to adapt the scheme to filament tubes. The system works because by returning the cathode to a tap on the grid coil instead of directly to earth, the R.F. plate current, as well as the D.C. ditto, is caused to flow through the part of the coil below the tap, inducing an R.F. voltage in the grid coil in the right polarity to cause regeneration. Now a cathode has only one terminal, and by having a single tap on the coil and taking the cathode to it, *all the* R.F. plate current has to flow through the lower part of the grid coil. But when the filament tube is used, the situation is different. We have the tap on the grid coil, as before, and to this we take one of the filament leads. The D.C. filament current has to flow through part of the grid coil, therefore, but this does not matter, because the resistance of the short piece of wire that makes up the coil is so small as to have no effect on the filament current. Now suppose we take the other end of the filament straight to the A battery. The latter, as well as providing direct current at 1.5 volts, acts towards alternating currents, and therefore towards R.F., as a very efficient bypass condenser. Thus, if we were foolish enough to expect such a scheme to work, we would be disappointed, because the A battery would act as a very effective short circuit for R.F., making the part of the coil below the tap completely ineffective, both as part of the tuning coil, and as a means of coupling part of the plate current into the grid circuit. One way out of the difficulty would be to insert an R.F. choke in the lead between the A battery and the free end of the filament. This would prevent the battery from short-circuiting the R.F. present on the filament, and would enable the scheme to work. The only difficulty would be that the choke used would have to have a very low D.C. resistance, so as not to drop the voltage actually applied to the filament. The usual short-wave R.F. choke of about 2.5 millihenries has a resistance of around 30 ohms, so that these could not be used. If a suitable low-resistance R.F. choke were specially made, it would be very bulky, and would almost certainly give trouble in other ways, so that the R.F. choke scheme is not really practicable. What we do instead is as follows. Suppose, for example, that the negative filament terminal is connected to a tap on the grid coil five turns up from the bottom of the coil. We now wind five turns over the top of the bottom five of the grid coil, take the upper end of this extra winding to the positive filament pin of the valve, and the other end to the postiive terminal of the battery. How does this scheme work?

Well, we now have two parallel paths by which R.F. components of plate current can flow to earth from the filament of the valve. One through the negative filament pin and the lower five turns of the grid coil, and the other through the positive filament pin and the extra five-turn winding we have added. These two paths

enable half the R.F. plate current to pass through each, and this will actually happen, because whatever the impedances of the paths may be at any particular radio frequency, they will always be equal, because each path consists of the same number of turns of wire, wound in the same way exactly, and coupled to the grid coil in the same way. Anyway, all the R.F. plate current must pass through one or other of the filament legs, and both legs are coupled to the grid coil, and will thus produce regeneration. This brief description of the working of the arrangement may not be strictly accurate, but from the functional point of view it is close enough to the truth to enable one of see why it works, as compared with the use of only one filament leg, which does not.

The plate circuit of the detector is choke-capacity coupled to the grid of the audio amplifier. This is very much better than the somewhat cheaper one of using resistance-capacity coupling, which is not very desirable as a means of coupling a regenerative detector to a succeeding audio amplifier stage. The reason is that a resistor considerably drops the voltage applied to the detector plate, thereby reducing the sensitivity of the detector. It is necessary to have a very high impedance in the plate circuit, and as far as the detector sensitivity is concerned, the higher the better. But it is undesirable to have a D.C. resistance of more than a few thousands of ohms, so that the A.F. choke is obviously the best sort of load impedance to use. Its impedance may be several hundred thousand ohms, but its D.C. resistance may be only a few thousand ohms. Thus, the plate voltage is kept high, and the gain is increased, both because of the high plate voltage and the high impedance of the choke. In commercial receivers and amplifiers, audio frequency chokes are very rarely used these days, but it is a simple matter to buy a small and cheap audio transformer and use one of its windings as a choke, the other being left unconnected. The correct transformer to use is any small inter-stage transformer with a step-up ratio of 3:1 or higher. An output transformer *could* be used as long as care was taken not to use the secondary winding, but it would not be likely to give as much gain as a small inter-stage transformer. The best method of using the transformer is to tape up the secondary leads so that they cannot come into contact with each other or with anything else, and then pretend that the secondary winding does not exist. The primary is then wired into the circuit. The purpose of the resistor R_2 should now be explained. Old hands will know all about "fringe howl," but for those who are perhaps building their first regenerative set, it will be a treat in store! Fringe howl is a very annoying and troublesome defect that often occurs in regenerative receivers. If one knows the cure (which is very simple) all is well, but should one not, it can render the set almost useless. It functions this way. When the reaction control is advanced in order to bring the set just to the point of oscillation (at which point the sensitivity is greatest) a loud howl is heard in the output, just *before* the proper R.F. oscillation of the detector commences. As a result of this howl, it is quite impossible to set the controls so that the detector is *just not* oscillating. It is either quite a long way from oscillation, in which case the sensitivity is too low for all but the strongest signals to be heard, or else it is actually oscillating, when 'phone stations cannot be listened to, even though their presence can be detected. Or, of course, it is producing this ear-splitting howl, too strong for anything else but an air-raid siren to be heard! This is what fringe howl does. Actually, it is an oscillation at some audio frequency, and its mechanism is rather too advanced for description in an article such as this. The main point is to know how to cure it should it occur. This is effected simply by shunting a resistor of high value across the detector's audio choke. The value needed to stop it will vary from set to set, so that builders may have to experiment with values to find just what is necessary. The idea is to use as high a value as possible, consistent with removing the howl. A very low value would certainly stop the howl, but it would also greatly reduce the sensitivity of the detector. In the original model the best value was 250k., but since no two transformers are the same, readers can expect to find quite large variations in the value required. Another point to remember is that fringe howl starts more easily when the batteries are nearing the end of their life, and is harder to cure the greater the internal resistance of the B battery. Thus, when the value of R_2 is chosen with new batteries in use, it may be found that when the B battery is nearly finished, the howl reappears. All that will have to be done, should this occur, is to put in a new R_2, of low enough value to stop the howl, even with the flat batteries. Then, it will not be necessary to change the value of R_2 again.



Note that all folds should be made downwards.

CONSTRUCTION

Many radio enthusiasts in the past have not paid sufficient attention to the mechanical construction of their gear, and no doubt there are many who will do the same thing in the future also. Because we are primarily interested in circuits, we have a perhaps natural tendency to say, "Is this a good circuit?" rather than "Is it a good *set?*" The two things have quite different meanings. Because any set is only as good as its construction, whatever the theoretical advantages of the circuit may be. The circuit is less than half the story, because it tells us only the electrical part of the design, and does not indicate in the slightest degree how the set can be built, or what is a suitable way of building it. How many people have admired a certain set, and its performance, gone away impressed with the "circuit," and had no success in building one for themselves because they used a different mechanical lay-out, or a different method of wiring it up? What these people should have admired is the *set,*

of which the circuit is only a shorthand way of saying *what* electrical connections should be made, not *how* they should be made. Of course, there is actually a great deal of latitude with some electronic devices. They can be laid out and wired up in a multitude of different ways, each of which will produce as successful results as the other. But other things, of which radio receivers are a good example, must be built in accordance with certain mechanical principles if they are to work properly. This does not mean that there is only one lay-out that will give a successful set from a given circuit—far from it. But we would like to impress on builders, and especially on newcomers to set building, that it is much more likely to be a successful receiver if it is built according to the recommended lay-out, because this one is one that has been tried out in practice, and found to work well. Even with a particular lay-out, there is some degree of latitude in the way in which the actual wiring can be performed, but it is our practice in this magazine to mention, as far as possible, all points about the wiring that need to be carefully followed. The photographs cannot give the exact position of all the small parts under the chassis, because some are unavoidably obscured, but we ourselves think, and there will be many that agree with us, that to give every detail, down to the exact position of the last ½-watt resistor, does not help anyone to become proficient at set-building. To get the greatest enjoyment out of building electronic equipment, one must learn enough to design one's own gear, both the circuit and the physical construction, and it is only by leaving a little to the initiative of the constructor that he is able to profit by experience. We hope, therefore, that our readers will agree that it is a good thing that we do not print detailed wiring diagrams showing the position of every component on the chassis. The complete tyro will in any case do better to get an experienced radio man to show him the small points about actual construction that he is unsure about, thereby learning a practical craft in the most practical way.

We have embarked on this rather long dissertation on construction in order to impress new readers with the fact that the way in which a set is built is every bit as important as the circuit it is built from. Ask anyone who now makes a neat, workmanlike job of his wiring whether or not it really pays! And then witness the disappointment of one who has made a very rough, untidy job of wiring, and finishes up with a set that does not work—and probably will not unless it is rewired!

The general appearance of the set can be seen from this month's cover photograph, which gives a partial view of the front panel and the top of the chassis. Unfortunately, this photo suffers rather from reflections occurring in the polished aluminium of the shield partition that separates the R.F. stage from the detector and audio tubes. However, if this photograph is taken in conjunction with the diagram of the chassis it will be quite easy to follow the the lay-out. The two large (1¼ in. diameter) holes on the chassis are for the valve sockets which hold the plug-in coils. The one near the front edge of the chassis is for the R.F. coil, and immediately behind it is the R.F. amplifier valve, V_1. Then comes the shield partition, and directly behind the R.F. valve, but on the other side of the shield is the detector coil. The valve next to this coil is, of course,

(Continued on Page 33.)

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„ „	12 in. x 8 in. x 2½ in.	14/–
„ „	9 in. x 7 in. x 2½ in.	10/6

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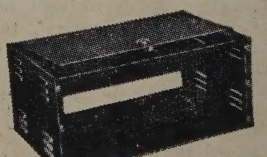

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A LOW-POWERED P.A. AMPLIFIER FOR ACCUMULATOR OPERATION

There are many possible applications for a small P.A. system in places where no A.C. mains exist, and a good many public address operators have probably felt the need for just such a system as the one described in this article. The circuit is one designed by Mr. A. McD. Cooper of Messrs. Green & Cooper, Ltd., Wellington, for use from the battery of a car or small van. It thus shows alternative arrangements for 6- or 12-volt operation.

INTRODUCTION

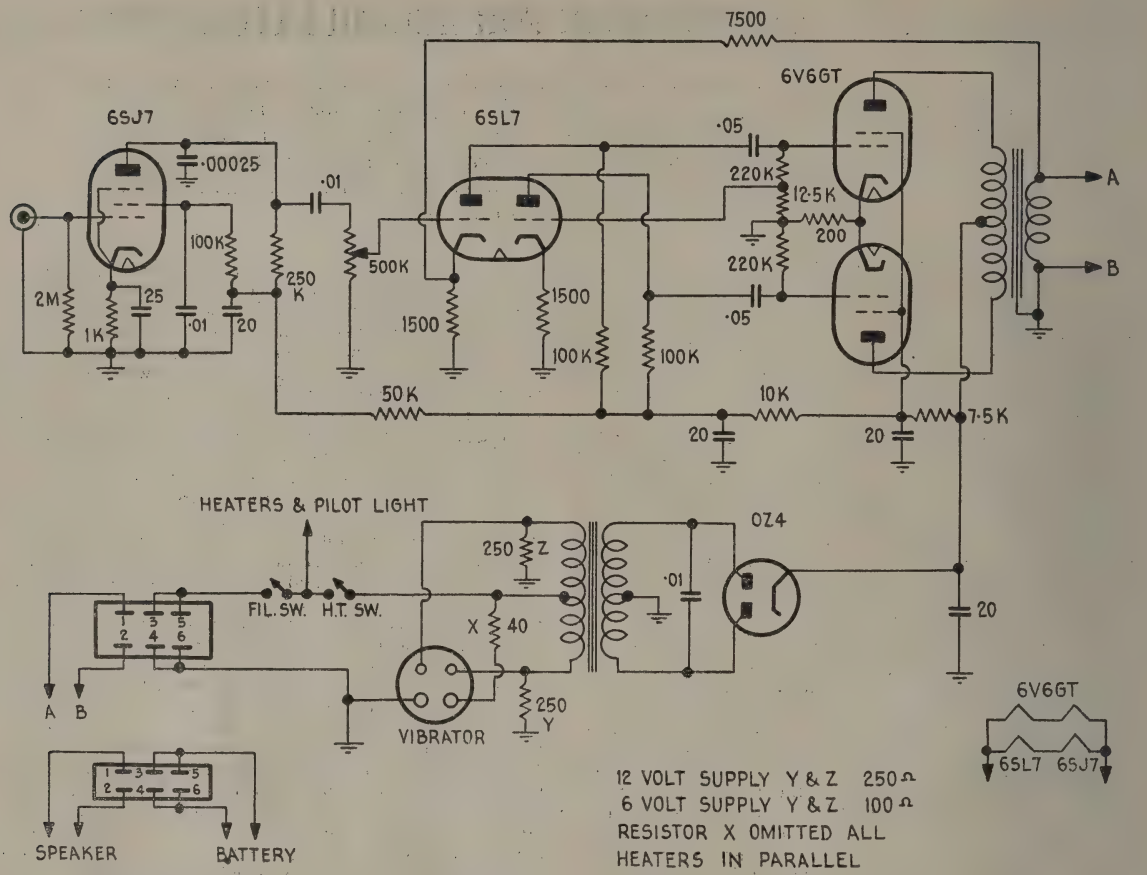
A small amplifier with a nominal output of nine watts or so is amply big enough for small public address jobs where a relatively small area is to be covered with sound. These jobs are, of course, simple when A.C. mains are available for use by the P.A. operator, but in the ordinary course of events, impossible without them. In the country, especially, an amplifier powered from a 6- or 12-volt battery can be of considerable use, while even in areas where mains are to be found, it will often be easier and quicker to set up a battery-operated amplifier than to run great lengths of lead from an operating position near the A.C. outlet that may be available. In fact, those P.A. men who do not already possess something of this kind will find one or two amplifiers like this one a very useful and inexpensive addition to their equipment.

THE CIRCUIT

For small jobs, it often occurs that a single microphone is all that is required, and so the circuit is a straightforward single-channel one, with a good performance, but no "frills." A single 6SJ7 is used as a microphone pre-amplifier, and this is followed by a 6SL7 as a high-gain phase-inverter, feeding a pair of 6V6s in push-pull. Overall feedback is used from the voice-coil winding back to the cathode of the first section of the 6SL7, and this is instrumental in reducing distortion to a low level. Since feedback is taken over only two stages, it is unlikely that trouble will be experienced from self-oscillation of the amplifier. It should be mentioned in passing, that the values shown for the feedback network, and in particular that of the 7500-ohm resistor from the voice-coil to the valve cathode, have been chosen for a 15-ohm loudspeaker. If a speaker of lower voice-coil impedance is used, the value of this resistor will need to be changed if the overall amplifier gain is to remain constant. With the lower impedance, and the same resistor, the amount of negative feedback would not be so great, with the result that the gain would be higher, and the distortion also. The effect would probably not be serious, however, but even so there is no reason why an increase in distortion should be tolerated, especially since there is plenty of amplification without reducing the amount of feedback. The value of the resistor directly determines the latter, and should have a value proportional to the square root of the speaker impedance. That is to say, if the impedance is a quarter of the standard 15 ohms, the resistor should be one half the one shown, or 3750 ohms, and so on.

It will be noticed that a fixed tap has been shown in the grid circuit of the second half of the 6SL7. This provides a fraction of the output of the first half of the same tube as the input for the second so that the output voltages of both will be the same. If desired, a 25k. potentiometer can be substituted for the 12.5k. fixed resistor, and used as a pre-set balancing control. However, it will be necessary to alter its setting only when tubes are replaced, and since the amplifier does not pretend to be a high-fidelity one, the fixed tap is quite satisfactory. The volume control has been placed *after* the pre-amplifier tube, because the microphone will never overload the first stage, and it is a good plan to have the control working at a point in the circuit where there is an appreciable signal voltage. This prevents the inevitable small amount of noise occurring when the control is shifted from being amplified more than necessary, and giving the impression of a potentiometer that is noisier than usual. Note also that the 6SJ7 is decoupled from the rest of the amplifier by a 50k. resistor in the H.T. feed, bypassed by a 20 μf. electrolytic condenser. This should on no account be omitted, for not only does the filter reduce hum and hash, but it is necessary in that without it there would be a danger of motor-boating. In order to make assurance doubly sure, there is also a decoupling filter of 10k. and 20 μf. in series with the H.T. feed to the 6SL7. In theory, this is not necessary to prevent low frequency oscillation, but it is nevertheless desirable in a circuit of this kind, where it will be observed that in order to reduce weight and cost, resistance-capacity smoothing has been used. This type of smoothing is more effective with a vibrator power supply than with an ordinary A.C. supply, because the A.C. turned out by the vibrator is much higher in frequency (approximately 115 c/sec.) and this makes the fundamental ripple frequency 230 c/sec. as against 100. It will be found that the R.C. smoothing shown on the circuit is perfectly adequate, in spite of its rather meagre appearance. Note that the plates of the 6V6's are fed straight from the reservoir condenser, while the screens are fed from the output of the main filter, with the 6SL7 plates taken off after the next filter stage. A graded filter of this sort is excellent practice, since it reduces expense to a minimum, and at the same time makes the degree of filtering suitable to the various H.T. feeds.

An OZ4 rectifier is shown. This has no heater, and thus economizes in current drain from the battery—always a worth-while point. The vibrator supply is very straightforward, and it will be noticed that there is no necessity to go in for elaborate R.F. filtering to remove "hash." It is important that the resistors shunted across the primary be of the values shown, and that the correct values be put in according to the operating voltage. The 40-ohm resistor in series with the coil of the non-synchronous vibrator enables a 6-volt vibrator to be run from a 12-volt supply, and saves the necessity of carrying spares of two kinds of vibrator should more than one amplifier, with different supply voltages, be carried to the one job. A standby switch enables the heaters of the valves to remain warm while the amplifier is not actually in use, and yet permits instant operation when the H.T. switch is thrown. This saves battery drain during long standby periods. Note that the pilot light is taken from the same point as the heaters, so that the operator can tell whether the whole amplifier is switched off or not. A further refinement would be a further pilot light fed from the other side of the standby switch, to show when the H.T. is on.



CONSTRUCTION

The construction can follow ordinary audio practice, and it is possible to make the whole amplifier, including the power supply, very compact and handy to carry about. Of course, if the power supply is included in the same chassis as the amplifier proper, it will be necessary to keep the pre-amplifier stage as far away from it as possible. From this point of view, it would be advisable to leave a little spare room on the chassis as as to prevent overcrowding. Anotfier necessary precaution is to take the feedback lead as far from the pre-amplifier circuit as possible, so that there will be no possibility of positive feedback arising through undesirable coupling to the 6SJ7.

If these points are looked after, no difficulty should be encountered, and the builder will find himself with an excellent amplifier with a multitude of applications that are not served at all by conventional A.C.-operated gear.

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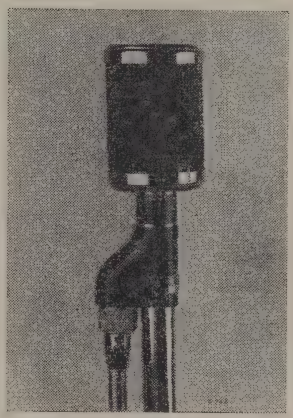
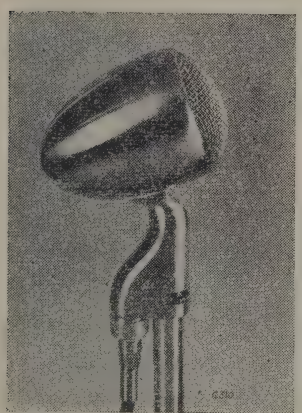
Ronette Microphone Cartridge, model B D X. As used in microphone models B 110 and G 310, are available for manufacturer and servicing. All-plastic housing with two eyelet-terminals. Technical details as for B 110 W and G 310 microphones.



S 742



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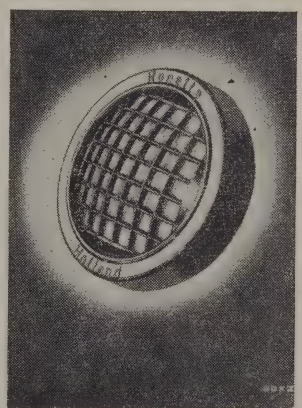

B D X

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SHOES and SHIPS

"The time has come," the Walrus said,
To talk of many things.
. . . . . "

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SIMPLE TOOLS TO AID THE SERVICEMAN

In service work one is frequently called upon to do a job of some unusual nature for which suitable tools are not available. However, the enterprising serviceman can generally improvise and by exercising a little ingenuity may overcome many difficult problems. There is no doubt though that correct tools are a great help. As a case in point the writer frequently has to do service work on midget transmitter/receivers and as these sets are built to economize on space as much as possible, the simplest jobs become quite difficult. Extracting a midget valve from its socket where it is surrounded by close packed I.F. transformers and R.F. coils is one particular instance. Finger and thumb are quite out of the picture for there is absolutely no room to get a decent grip of the tube which, incidentally, is usually hot, just to add to the general "cussedness" of the situation. Failing any other method it was found possible to get away with it by means of a pair of pliers with rubber strip sandwiched between the jaws and the valve itself. Tubes were undoubtedly extracted by this method but quite a few were "pranged" also. Fortunately, a British manufacturer who must have stood in attendance at an operation and marked the general profanity and surveyed the wreckage of sundry valves foresaw this problem and the result is that a neat little extracting tool is now available at modest price to do this job quickly and very carefully. This tool is quite staggering in its simplicity, consisting merely of a metal tube just a neat fit over the valve envelope. The bottom inside part of the metal tube is turned out on a taper and a rubber ring is inserted inside this tapered section. When pushed down over the valve it slips on quite easily but when it is pulled up the rubber ring rolls down the taper and tightens firmly on the valve and out it comes with a minimum of effort. For an interesting half hour we suggest you try one of the miniature types on your finger!

This same manufacturer has also produced another tool which has proved its worth for straightening and aligning the pins of miniature button base valves. This consists of a steel plate with funnel-shaped holes to guide the pins of the valve into the jig. Side supports to the tool keep the valve pins straight with respect to the valve itself.

These tools also bring to mind another very valuable asset to the workshop which is available locally in a variety of sizes—this being a very effective chassis hole cutter. Many are the times a serviceman finds it necessary to cut a hole in a chassis perhaps for mounting an electrolytic or an extra valve or even perhaps the cutting out of a new chassis from the blank state. This particular tool cuts a neat, well-finished hole and by a clever method of shaping the male portion of the cutter spreads the cutting pressure fairly evenly besides bending the blank so that it is easily removed from the tool when the operation is completed.

The cutting pressure is applied by means of a screw shaped to take the Allen wrench lever provided and this is constructed in such a manner that it is quite simple to cut a hole in an assembled chassis without removing any of the components nearby. This is a great improvement on the time-honoured method of drilling a series of holes around the edge of the piece intended to be removed and then finishing the hole up with a file.

Admittedly it works but components already on the chassis generally take considerable punishment in the process and P.M. speakers in close proximity finish up looking like Brother Jim's face after a week in the bush!

These three tools are well worth the serviceman's consideration, for, while it is conceded that a job can generally be done "somehow," what a difference it makes to have these helpful accessories to hand.

* * *

AN UNUSUAL CONDENSER FAULT

An unusual fault encountered recently in a domestic radio set prompts this story. The person concerned had a grudge against his radio for a particularly annoying fault which, although it did not prevent the set being used, caused more than the odd spot of grief in the family circle. This radio, when switched on, took longer than usual to heat up and when it finally came into operation did so with a loud "pop" and produced sound at full blast to the discomfort of the listener who had turned up the volume to see where the music had gone to.

The serviceman's first thought on this subject is, of course, that the local oscillator is coming into operation suddenly, but well after the rest of the valves have reached operating temperature. However, a check on the oscillator revealed that this misjudged section of the set was functioning properly before sound came from the set.

During this check, however, one fact came to light—the H.T. voltage was rising to expected initial no-load peak then slowly falling as the valves heated up. It did, however, continue to fall below what might have been expected until the "pop" heralding the coming into operation of the radio sent the B voltage up to normal level. Condensers in general now became suspect but a quick check on all likely offenders revealed nothing. At this stage that sixth sense which all radiomen develop, suggested measuring the bias voltage on the grid of the output valve; this bias being developed across a resistor network in the centre tap of the power transformer secondary. Here things started to go all wrong, for instead of the expected negative bias a strong positive voltage was present until the "pop" reversed the order of things and voltages became normal. The fault was now very apparent—the coupling condenser was obviously breaking down on the high initial B voltage and impressing a positive voltage on the grid of the output valve. As this valve warmed up it drew progressively heavier current until it pulled the high tension down to such a level that the coupling condenser sealed itself off with a "pop" and the set came into operation suddenly. The B voltage, of course, rose to normal but this apparently was not sufficent to cause the condenser to break down thereafter while the set was running. A new coupling condenser of the appropriate type rectified matters and the owner, now reconciled to his wayward music box, departed in pleasanter frame of mind.

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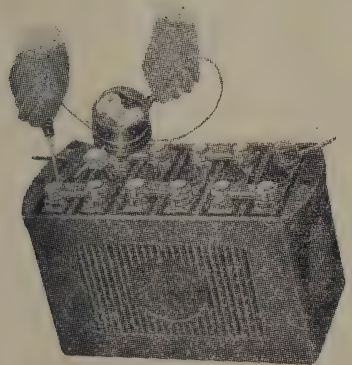

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SOME WAVE-FORMS AND HOW TO MAKE THEM

Now that television has become rather more than something which requires a telescope to see, many radio men will be interesting themselves in TV circuitry, much of which makes use of valves in, to the uninitiated, very peculiar ways. Those familiar with radar circuits will know what we mean by this, but we think that some of the wave shapes that are produced by the said valves are becoming of basic importance in a number of fields other than TV and radar, and should therefore be more familiar to people who hitherto have confined their interests mainly to distortionless amplifiers.

INTRODUCTION

Electronics is a very wide field, as everyone is aware, and the things that valves are called upon to do are many and varied, and far removed from the stereotyped amplification of signals with as little distortion as possible. Unless our activities have brought us into direct contact with devices which use tubes, but which make no attempt to amplify in a distortion-free manner, it usually comes as a shock when we encounter for the first time circuits where small receiving valves are provided with no (or even positive) bias, and input signals of several hundred volts R.M.S.! Such things just do not seem right, and it is difficult at times to visualize what they do and how they work, unless one has been "primed," as it were, beforehand. The purpose of this article, then, is to describe some waveforms that seem to bear no relation to the familiar and ubiquitous sine-wave, and to outline some of the methods by which they are produced. Of course, one non-sinusoidal that occasions no raised eyebrows at all, and for which various recipes are familiar to most, is the saw-tooth, which has gained such prominence, owing entirely to the extensive present-day use of the oscilloscope as a test instrument.

The waveforms to which this article refers are illustrated in Fig. 1. At (a) is a square-wave, at (b) and (c) are two kinds of narrow pulse, and at (d) is a series of alternate positive and negative narrow spikes, usually known as "pips." These by no means exhaust the non-sinusoidal waves that can be encountered, but are all of considerable importance, and are themselves the starting points from which more complex wave-forms are made. In this article it is intended to show some of the methods by which such wave-forms are made—methods which are in very common use, and which are of fundamental importance to many different types of equipment.

DEFINITIONS

Unfortunately, the classification of wave-forms into square-waves and pulses is not a very satisfactory one. There do not seem to be any fool-proof definitions of either, which sometimes causes confusion to the uninitiated, so that it might be as well to say a few words on this aspect before proceeding to the question of how they are made.

SQUARE-WAVES

While there is, as we have said, no hard and fast definition, it can be conceded that the one feature of a square-wave that seems common to every writer on the subject is the fact that it has square corners, in direct contrast to the sine-wave, which is a smooth curve. If we simply define square-waves as waves that possess only square corners, then clearly the three waves shown in Fig. 1 (a), (b), and (c) all come within the scope of the defintion. For reasons that will appear, it seems safest to use something like this as a standard definition, with the additional proviso that pulses are simply special cases of square-waves. If we accept the definition of a square-wave suggested above, then the latter proviso is really self-evident. But in order to talk more easily about pulses, and to have a ready method of distinguishing between the two main kinds of pulses shown at (b) and (c), it is necessary to go a little further. First of all, one should have clear in one's mind the fact that a wave-form is a graph. It is simply a graph showing how a particular kind of alternating current or voltage behaves with respect to *time*. That is to say, if the voltage (or current) at a certain point in a circuit varies in a particular manner, and goes on repeating that same variation indefinitely, the voltage is said to be recurrent, or cyclic, and every complete variation is said to be one *cycle* of a *wave*. Thus, in order to describe in the shortest possible time the precise manner in which the recurrent variations in voltage occur, the best thing to do is to draw a graph in which *time* is represented by distance along a horizontal line, while the voltage or current whose behaviour we are describing is represented by distance above and below this horizontal axis, and thus by distance along the vertical axis. Should the voltage be a true alternating one (*i.e.*, going first in one direction and then in the other) some of the graph will appear on one side of the horizontal axis and some of it on the other side. This is because the horizontal axis itself represents zero on the voltage or current scale, and because the area on one side will then represent, say positive voltages, while the part of the graph on the opposite side will represent negative voltages. In the case of currents, the area on one side will represent cur-

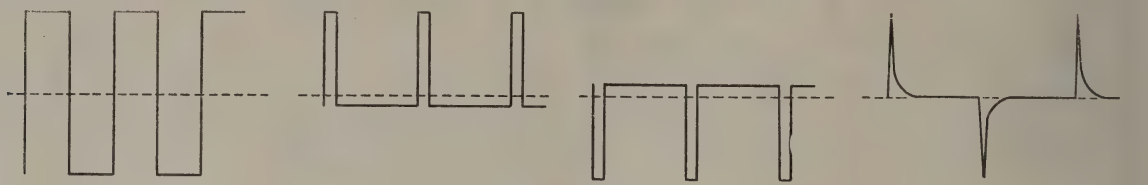

Fig. 1

rent flowing in one direction, while that on the other side of the horizontal axis will represent current flowing in the opposite direction. In mathematics, it has been decided that above the horizontal, or x axis, will be called *positive,* so that points below the x axis must represent *negative.* Also, to make a graph completely general, the part to the *right* of the vertical axis is called *positive* for the quantity measured along the x axis, while the part to the *left* of the vertical axis is called negative. Those who are not clear on these points are strongly recommended to consult an elementary algebra book, where the chapter on graphs should make the whole thing clear. For some purposes, we do not require the area on one side or other of one axis, simply because the thing that we measure along the other axis never has values that would put the graph into that area. In the present case, as we have said, time is measured along the horizontal axis, and because time can never be considered to have negative values, the whole graph must lie to the right of the vertical axis. For this reason, there is no need to show the position of the vertical axis except where the graph has actual time values, and therefore a time scale, drawn on it. But for the full meaning of the graph to be apparent, it is necessary to show the position of the horizontal axis. This has been done in Fig. 1 by means of the dotted line in all cases. This is an important point, and when in a moment we get back to more practical considerations, its practical significance will be immediately apparent.

Let us consider the usual sine-wave for a moment. If it is true sine-wave, the shape and size of the parts above the x axis are identical with the shape and size of the parts below it. In other words, the positive and negative voltage or current changes occur in exactly the same way, except for the fact that they *are* positive and negative respectively. Thus, for a sine-wave or for any wave in which the parts below the x axis are of the same shape as the parts above it, the wave must extend by equal amounts on either side of the axis, or *datum line* as it is often called.

Now let us see if this fact has any physical meaning. Suppose our sine-wave represents the current flowing at a certain point. During one half-cycle, the current flows in one direction, and by the time the half-cycle has finished, a certain amount of current has flowed. On the next half-cycle, exactly the same amount of current flows, *but in the opposite direction,* so that averaged over the whole cycle, and at the end of it, the electrons that move and cause the current are in the same position as at the start of the cycle. In this sense, therefore, the average current at that point can be said to be zero. And if we are thinking about current in one particular direction, this is true. That is to say, if the current is observed by a meter or other instrument *which is sensitive to the direction of the current flow,* it will not read at all, and will tell us that NO CURRENT HAS FLOWED AT ALL. We know this is not true, because if we had used some means of detecting the current that is not affected by the direction of the flow, but only by its presence, it would tell us that current has in fact flowed. This it will be seen is the difference between A.C. and D.C. meters.

Now, to get back to our waves and their shapes, suppose our graph shows us a sine-wave, but with the x axis, or datum line nearer one side than the other; the question arises, "is this possible, and if so, what does it mean?" The answer is that it is possible, and that it means that as well as the alternating current, or sinusoidal shape, we have present some D.C. which keeps on flowing in the same direction, regardless of the presence of the A.C. In this case, the parts of the wave above the datum line will *not* be equal in area to those below it, and therefore the quantity of current (or number of electrons) flowing in one direction is not balanced by the quantity (or number) that flow back in the opposite direction. In this case, an A.C. meter and a D.C. meter would both read. The D.C. one would measure the D.C. component only, ignoring the A.C. part in the usual way, while the A.C. meter would read the effective current due to both, for such a meter cannot distinguish between A.C. and D.C., and reads on both.

All this may seem a bit theoretical and academic, but it is not in reality, as those who read on will find out! What we are leading up to is the fact that every waveform has its axis or datum line, and it is important to know, in the case of all but the obvious ones, where the datum line is. The whole question is actually rather easier to see when referred to a square-wave like Fig. 1 (a) than when applied to a sine-wave. In Fig. 1 (a) the datum line has been drawn mid-way between the peak values in either direction. Remembering what has been said, and assuming that there is no D.C. component present, it is not difficult to see that this is correct. With the square-wave, we have a rather simple state of affairs, in that the flat portions obviously represent a steady current of the same value, for as long as they last, so that each half-cycle can be regarded as D.C. of a certain value, lasting for a certain time. The vertical portions of the wave mean simply that at the end of each period of D.C. there is an instantaneous change to another value of D.C., on the other side of the datum line.

Now, if the whole wave is a pure alternating current, the number of electrons flowing during each half-cycle must equal the number flowing back in the opposite direction during the next. And our term "current" actually means *a rate of flow of electrons,* so that if we multiply the current, or the rate of flow, by the time for which the flow takes place, we will obviously have a measure of the number of electrons, or the quantity of electricity that has passed during the time under consideration. It was pointed out earlier, moreover, that on our graph, distance vertically means the strength of the current, while distance from left to right represents *time.* Thus if we take the *area* of one half-cycle, it must represent the quantity of electrons that has flowed during that half-cycle. But for no direct current to be present, the quantity flowing during each positive half-cycle must equal the quantity flowing during each negative half-cycle, so that the areas of the half-cycles must be equal. This is the first important point. The second is that in the square-wave shown in Fig. 1 (a) the positive and negative half-cycles are of equal duration. Thus, for their areas to be equal, the heights above and below the datum line must be equal.

By using a square-cornered wave for an illustration, it has been possible to show by simple arithmetic that for *any* wave that is a pure alternating current, containing no D.C. component, the areas of the half-cycles on either side of the datum line must be equal, and also, whatever the wave shape, the datum line must be in such a position that this is true. Thus we come to the question of pulses.

WHAT ARE PULSES?

Pulses may be defined as square-cornered waves in which the portions above and below the datum line are *not* equal in amplitude.

Take, for example, Fig. 1 (b). Here, the current flows in one direction for a much longer time than it does in the other. For this reason, remembering that this is a

pure alternating current, it follows that the datum line must be in some position like the one shown. The *exact* position is the one which makes the positive half-cycle's area equal to that of the negative half-cycle. In general, such waves are produced in the plate circuit of a valve, as we shall find out, and in this case, there will be the D.C. plate current of the valve added to the A.C. current which is the wave, but if we insert the usual coupling condenser, the D.C. component is blocked in the usual way, leaving only the A.C. wave, and it is because of this that we need to know where the datum line of the wave lies. Such waves are made not to look at, but to use, and as we shall see, it is important from this point of view to be able to estimate where the datum line is. For example, the wave in Fig. 1 (b) could well be used to trigger off a time-base, or to cause an oscillator to function only for the duration of the short positive portion. If we are to use the wave for this purpose, one of the things we must know is its effective voltage *in the positive direction,* because circuits which are triggered in this way usually have a critical voltage, so that if the triggering pulse is smaller than this voltage, triggering will not take place. We can quite easily display the pulse on the oscilloscope, and also use the 'scope to measure the voltage amplitude between the positive and negative limits of the wave. One hundred volts, for example. But in applying the wave to the circuit it has to trigger, the chances are that it has to be passed through a blocking condenser, so that at the grid of the triggered valve, for example, we have not only positive voltage excursions, but negative ones as well. For triggering purposes, the negative ones are useless, so that unless we know where the datum line is, a measurement of the peak-to-peak amplitude, such as we can make on a 'scope will not tell us the amplitude of the positive portion—the only bit in which we are really interested. But by measuring the relative durations of the positive and negative portions, as well as the peak-to-peak amplitude, we can work out by simple arithmetic how much of that amplitude is positive with respect to earth, and how much negative. For example, if the positive portion is one-fifth of the whole cycle, and the negative portion lasts, therefore, for four-fifths of it, then the amplitude of the positive pulse must be four-fifths of the peak-to-peak voltage, and the negative portion, one-fifth. Only if this is so can the areas on either side of the datum line be equal.

In Fig. 1 (c), we have a wave of exactly the same shape as in (b), except that the long-duration portion now goes positive, while the short bit is negative. It is really the same wave-form as (b), but in practice it is regarded as different because it can be used in a different way. A sine-wave, or a wave like Fig. 1 (a) not only looks the same whichever way up it is, but if passed through a circuit, of whatever kind, does the same things. A pulse, on the other hand, will obviously do very different things in a circuit, according to which way up it is. In our imaginary case of the triggered oscillator or time-base, we may have required a voltage of 75 in order to perform the triggering action. The wave of (b), if 100 volts peak-to-peak, would easily do this, but if we passed it through another valve for some reason before using it to do the triggering, it would not work at all, because what was the positive portion is now the negative portion. Pulses, therefore, have to be subdivided into two kinds, even if their shapes are identical, as in (b) and (c). Unfortunately, there is no standard naming for pulses, and this frequently causes confusion.

(To be continued.)

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Vacuum Tube Methods of Measuring Insulation Resistance Of Condensers

By the Engineering Department, Aerovox Corporation

Users of condensers often do not have an accurate way of determining the insulation resistance or leakage of a paper condenser. The leakage of a good condenser is so small that ordinary milliammeters will not give a reliable indication. The methods usually employed by servicemen and experimenters are rather indefinite and leave the radioman still in doubt regarding the true condition of the condenser under test. In response to many requests this number of the Research Worker is devoted to the accurate measurement of insulation resistance of paper condensers by means of a vacuum-tube-voltmeter.

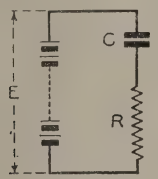

Fig. 1

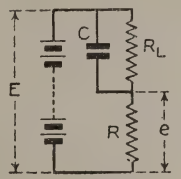

Fig. 2

Fundamentally the measurement is very simple. Fig. 1 illustrates the test circuit; the condenser under test, C, is connected across a direct current source of a convenient high voltage in series with a resistance, R. After the condenser is charged, a small current will still flow which is the leakage current. The equivalent circuit of Fig. 2 shows the condenser as a condenser with a resistance R_L across it. It is now required to find the magnitude of R_L. This can best be done by measuring the voltage drop, *e*, across R; the value of R can then be calculated if the voltage of the battery is known. How this is done is perhaps best shown by a numerical example.

Suppose the battery delivers 400 volts and the value of the resistor R is 1 megohm. After connecting the condenser in series with R and waiting for the condenser to be charged, the voltage drop across R is found to be 1 volt. Since 1 volt out of the 400 is across R the other 399 must be across R_L. In a series circuit the voltage drops across two resistors are proportional to the resistance so R_L must be 399 megohms. Similarly, if the voltage across R had been 2 volts, the insulation resistance would have been 398/2 = 199 megohms. A voltage drop of .1 volt across R would mean that the insulation resistance R_L would be 3999 megohms.

Generalizing the above statements we can express the relations in an equation, as follows:

$$R_L = \frac{(E-e)\,R}{e}$$

In this equation the results will be in megohms when R is in megohms. E is the voltage of the battery and e is the voltage drop across R.

Let us postpone for a while the problems of getting a satisfactory sensitivity, the discussions of the limits for the values of R, etc., and concentrate on the circuit itself.

Fig. 3 shows the simplest circuit of a vacuum tube voltmeter connected across R. In this case the vacuum tube voltmeter is used for measuring a steady voltage and therefore can work on the straight part of its characteristic and not on a bend. However, in order to have a larger range and to save on battery drain the bias of the tube can be larger than the regular amplifier bias so long as the operating point is still on the lower end of the straight portion.

In Fig. 3 the switch Sw_1 has been introduced in order to charge the condenser first. The method of operation is now to heat the tube and connect the condenser, then to set the switch at a. The condenser will now be charged through the resistor R_2. This resistor has been placed there for protection of the battery in case the condenser were shorted. In fact, it would be best to place a meter in series with R_2 making the combination a voltmeter. The value of R_2 should be such that together with the meter it makes a voltmeter with a

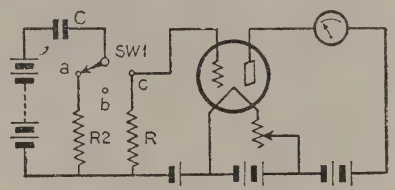

Fig. 3

maximum range equal to the voltage of the battery. It is also possible to use a neon light instead of a meter and R_2. The neon light will first light up when the condenser is being charged, thereafter it should go out altogether. If the lamp remains glowing, the condenser is shorted; if it flashes intermittently the condenser is leaky.

Now that the condenser is charged and it has been established that it is not shorted or so leaky as to place a high voltage on the grid of the tube, set the switch Sw_1 to c. The vacuum tube voltmeter now should show an increased plate current and this can be read as a voltage across R. The value of R_L is now found with the equation which was given above.

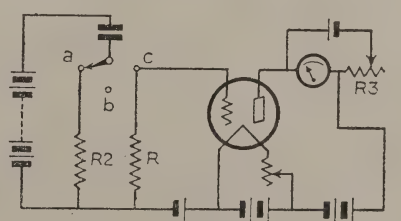

Fig. 4

The circuit of Fig. 3 would not be sensitive enough for most purposes but it can be improved upon by balancing out the steady plate current which will then permit the use of a more sensitive meter. There are several ways to accomplish this. One of them is shown in Fig. 4; a 1.5-volt cell and a 1000-ohm rheostat will accomplish the desired result. These values are correct for most cases where a low resistance meter is employed (with a range of 0—1 ma.). More sensitive

meters may have a higher resistance and then it is better to use a higher voltage source and a higher value of the rheostat R_3. The rheostat is across the meter and constitutes a shunt; unless its resistance is large compared with the internal resistance of the meter, the sensitivity will be seriously reduced.

Now a word of warning; it is unlikely when first adjusting the circuit that R_3 will be set at once to the correct position for zero current through the meter. Consequently there might be a rather high current flowing through it which might damage the meter. Therefore, wherever we show a measuring instrument in this article it is advisable to employ a sensitive instrument with several shunts so as to prevent any overload. Suppose the meter to be an 0—100 micro-ampere range, it should have shunts for 0—1, 0—10, and 0—100 ma. and an off position. In this way, the balance can first be approximated on the higher ranges where the danger of overload is not present. Then, if the balance is obtained, switch to a lower range and make finer adjustment and repeat this until the instrument shows zero current at its lowest range.

Another method of cancelling the steady plate current is by means of the bridge circuit of Fig. 5. A load resistor, R_4, is in series with the plate circuit of the tube. Its value should be calculated so as to obtain the rated

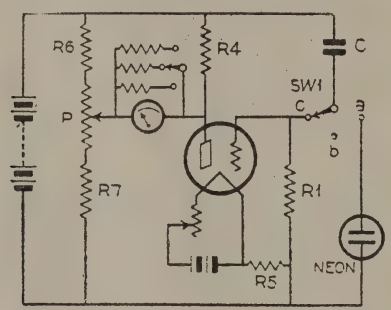

Fig. 5

voltage at the plate of the tube with the plate current which is desired. Also, instead of the added C-battery for the tube, a bias resistor can be employed. This is possible in Figs. 3 and 4 as well. The meter—with its shunts—is connected between the plate of the tube and a point on the bleeder resistance having the same voltage so that no current will flow. The potentiometer, P, will enable the user to find the correct point.

This circuit has the advantage that the adjustment and calibration will not be affected very much by the dropping of the battery voltage. On the other hand it increases the drain on the high voltage battery but the total drain need not be high. The tube itself might draw about 2 ma. and the bleeder about the same. It is possible to obtain a similar balance by omitting the bleeder and connect P across one or two cells of the battery but then the adjustment will not be so well maintained with the variations in battery voltage. The value of R_6 and R_7 can so be chosen as to make the potentiometer P less critical which will also be a safeguard against overloading the meter.

CALIBRATION

There are two ways of actually reading the desired voltage, e. The vacuum tube voltmeter can be calibrated with known battery-voltages or the slide-back method can be used. This latter method requires no calibration.

A suitable circuit for calibration is shown in Fig. 6. The presence of a high resistance in the grid circuit of the tube may result in some gas current with consequent lowering of the input impedance of the tube which might change in turn the value of R_1. We shall show later how to test for this error but when calibrating the meter, the resistance should not be paralleled by a low resistance. The series resistance R_8 might be nine times R_1 and then the voltage applied to the grid of the tube is one-tenth of that shown on the voltmeter V.

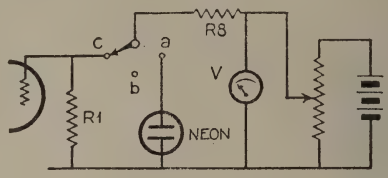

Fig. 6

Changes in battery voltages and in the tube characteristics may affect the calibration. It is a good idea to check it frequently. If different ranges are to be obtained by using different values of R_1, a separate calibration should be made for each range. It may be that it is satisfactory to multiply all reading with a fixed number, but this had better be checked.

For a fixed battery voltage and a fixed value of R_1 the meter can be calibrated directly in megohms.

The slide-back method really provides a new calibration for each reading and the accuracy is not influenced by the changes in battery voltages or tube characteristics. Moreover if there is any voltage drop across R_1 due to gas currents, this voltage would not cause any error. The only critical part is the circuit of the tube containing the resistance R_1. It is important that there be no leakage in the socket or insulation and that the input impedance of the tube is sufficiently larger than R_1 so as not to lower its value.

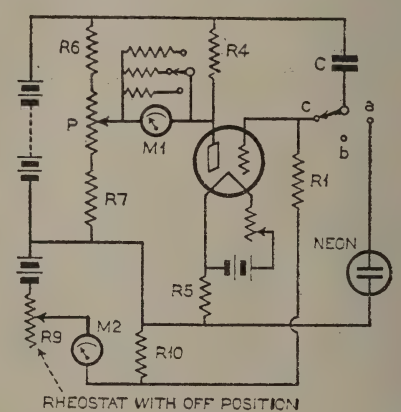

Fig. 7

Fig. 7 shows the slide-back circuit added to Fig. 5. It consists in adding a negative voltage to the grid bias in opposition to the voltage drop across R_1. When this voltage is equal to e, the meter will again indicate zero. The value of e is then indicated on the meter, M_2. The procedure of a measurement is now as follows. Set Sw_1 on a and connect the condenser; assuming that the light goes out after the charge we proceed with the measurement. With the tube filament heated, obtain the balance of the meter M_1 by adjusting P. This must be done with R_9 on the off position. For purposes of accuracy it is best to adjust the meter M_1 to some sharply defined division on the scale preferably as near as possible to the zero point rather than to zero itself. It

should be a fine line so that the least change in the position of the needle can be easily detected. When the adjustment of P has been made, set Sw_1 on c and the needle should move up. Now adjust R_9 until the needle returns to its original position. When this is done read the milliammeter M_2. Suppose R_{10} is 100 ohms, and the meter M_2 a 0—1 ma. meter, a meter reading of .5 would mean that the voltage drop across R_{10} (and also across R_1) is .05 volt. In order to get different ranges it might be found advisable to switch R_{10} and to use values of 100, 1,000, and 10,000 ohms or to use a multi-range meter or both. In reality the meters M_1 and M_2 can be the same. They can be switched as shown in Fig. 8. The resistance R_{11} should equal the meter resistance so that the adjustment of R_9 can be done while the meter is in the other circuit; the switching over then will not change the current through R_{10}. It is also possible to calibrate the rheostat R_9 using a dial and do away with M_2 altogether.

When the value of e has been found, the insulation resistance of the condenser is found from the equation

$$R_L = \frac{E\ R_1}{e}$$

Note that the equation for the slide-back method is slightly different from the one for the calibrated meter.

SENSITIVITY

The equations indicate that the sensitivity depends on the value of the battery voltage and the resistor R_1 as well as on the sensitivity of the voltmeter. The apparatus can be made more sensitive by increasing the value of R_1. Since it is necessary to measure insulation resistances as high as say 10,000 megohms it is important to know how far we can go in increasing R_1.

All tubes have some gas left in them; if a high resistance is used in the grid circuit, the gas current flowing through this resistor will cause a voltage drop across it which may cause an error with a calibrated meter. However, the presence of the gas current means that the

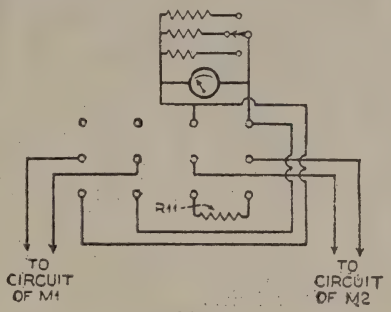

Fig. 8

tube acts as a resistance connected across R_1 and thus may considerably change the resistance of the circuit. In that case the wrong value for R_1 is used in the computation and this causes another error. Poor insulation of the grid terminal will have the same effect.

The remedies are to employ a tube which has its grid coming out on top, such as the 32, 36, 24, etc. These can be used as triodes by connecting plate and screen together. A grid-leak of 1 megohm can usually be employed with these tubes. It may be possible to go to 5 megohms, but then the following test is recommended. Employing the slide-back voltmeter, connect a known high resistance of 20 or more megohms (but accurately

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known) in series with R_1 as in Fig. 5 and measure a known voltage. This should then check up with the reading on M_2.

The voltage E should be some convenient high voltage near the rating of the condenser under test, 400 or 500 volts is recommended; even 200-volt condensers can be tested at this voltage. Unfortunately, it is not practical to employ a power pack here; batteries must be used. The customary power supply is subject to continuous small fluctuations in the voltage. These small fluctuations charge and discharge the condenser which results in amplified variations in the voltage across R_1. These are amplified still more by the tube and result in violent variations in the meter reading. This is especially so for large condensers. It is then quite impossible to obtain a balance or a reading. None of the usual schemes for automatically regulating the supply have been found accurate enough to permit their use with this measuring instrument at its sensitive settings. Consequently batteries are the only solution.

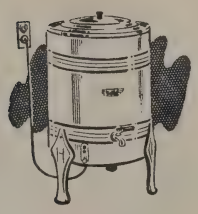
RANGES

There is considerable variation in the insulation resistance of condensers. The large ones have considerably more leakage and it will be found that a single value of R_1 will not be found satisfactory for all purposes. It is recommended to use two or three different values of R_1 so as to obtain different ranges. In addition the resistor R_{10} may have to be changed.

INTERPRETATION OF READINGS

The insulation resistance of paper and mica condensers is inversely proportional to their capacity. A

(Continued on Page 45.)



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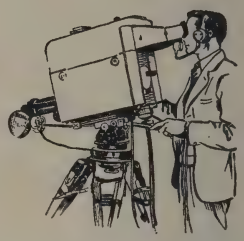

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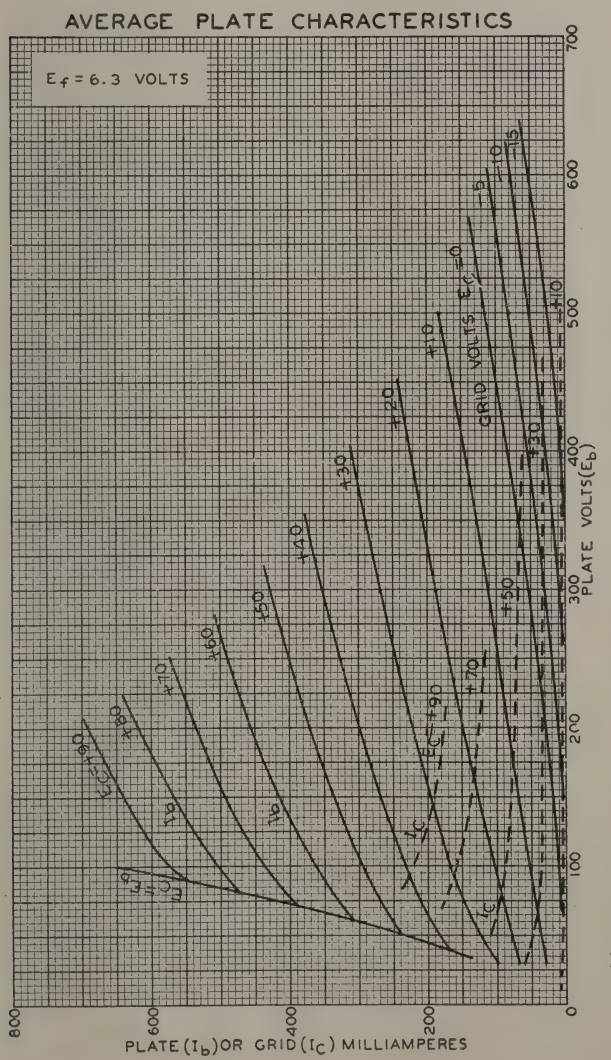
TUBE DATA: Some Lesser-known but Useful Valve Types—Part I

While we are comparatively well-off for standard valve types, in that quite a comprehensive range of miniature and standard octal valves are continuously available from a number of sources, there are a multitude of types that are of considerable interest to amateurs, experimenters, and professional men alike, and yet not officially available at all. In this category come numerous valves that are available on the war surplus market in considerable quantities, and it is the more useful of these that we intend to describe in some detail for the benefit of readers, who may not have the characteristics of these tubes handy for reference. This month we feature the 7193/2C22 and the 3A5/ECC90, both of which should be found of considerable interest.

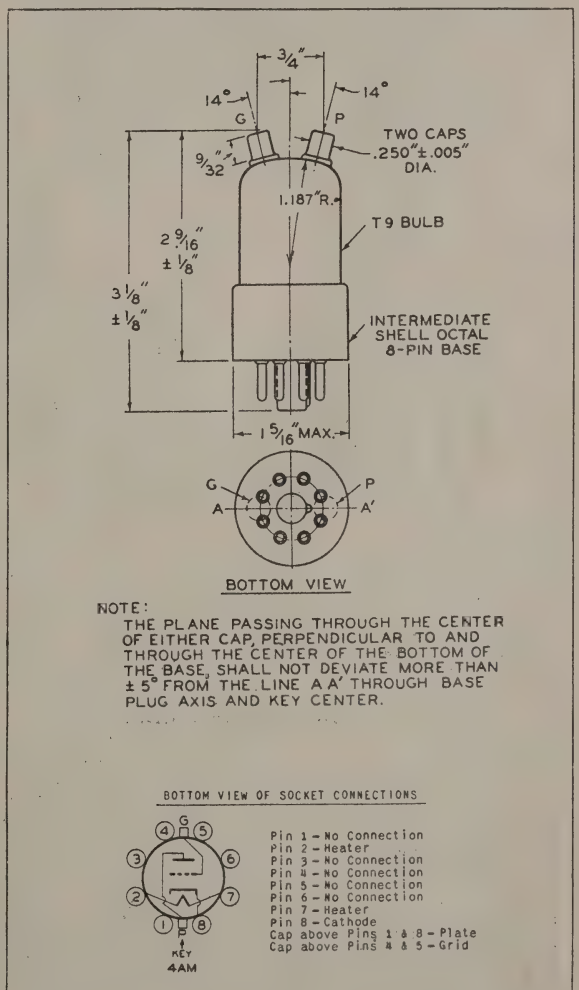
THE 7193/2C22 V.H.F. TRIODE

The 7193 is a small triode, designed specially for use at very high frequencies, that is available in quantity on the surplus market, having been used in large numbers of American-built I.F.F. sets during the war. It has a conventional octal base and small GT type envelope, and is similar in electrical characteristics to the well-known 6J5. Its appearance is distinctive ,however, since both grid and plate connections are brought out to miniature caps at the top of the bulb. The base pins are therefore used only for mechanical support in the socket, and for leading in the heater voltage by the usual pins, numbers 2 and 7, with the cathode, of course, to pin number 8 in the usual way. The diagram on this page shows its dimensions and socket connections.

To the best of our knowledge, this type has not been featured in the R.C.A. handbooks, but has been superseded comparatively recently by type 2C22, with which it



TYPE 7193/2C22


3/4"
14°
14°
G
P
TWO CAPS .250" ± .005" DIA.
9/32"
1.187" R.
T9 BULB
2 9/16" ± 1/8"
3 1/8" ± 1/8"
INTERMEDIATE SHELL OCTAL 8-PIN BASE
1 5/16" MAX.
G
P
A
A'
BOTTOM VIEW
NOTE:
THE PLANE PASSING THROUGH THE CENTER OF EITHER CAP, PERPENDICULAR TO AND THROUGH THE CENTER OF THE BOTTOM OF THE BASE, SHALL NOT DEVIATE MORE THAN ± 5° FROM THE LINE A A' THROUGH BASE PLUG AXIS AND KEY CENTER.
BOTTOM VIEW OF SOCKET CONNECTIONS
Pin 1 - No Connection
Pin 2 - Heater
Pin 3 - No Connection
Pin 4 - No Connection
Pin 5 - No Connection
Pin 6 - No Connection
Pin 7 - Heater
Pin 8 - Cathode
Cap above Pins 1 & 8 - Plate
Cap above Pins 4 & 5 - Grid
KEY
4AM

is identical physically and electrically as far as the user is concerned. We are not sure, but it may be found that some examples of the tube have the composite number 7193/2C22 stamped on them, but the only ones we have seen ourselves simply have the designation 7193. Not all the characteristic curves are given here because it is believed that the static characteristics are identical with those of the 6J5, information on which everyone will have. There is an important difference, however, in that the 7193/2C22 is rated for a maximum plate voltage of 300. This figure is given as for continuous commercial service (C.C.S.), while it is stated that in Intermittent Commercial and Amateur Service (I.C.A.S.) the plate voltage may be as high as 500 volts. However, in this rating, the maximum plate dissipation of 3.3 watts remains unchanged, so that operation at high plate voltages than 300 will normally require a decrease in D.C. plate current in order to keep the tube within its ratings. At 300 volts, and with —10.5v. bias on the grid, the plate current of 11 ma. gives a mutual conductance of 3 ma./volt, and an amplification factor of 20. At this, the plate resistance is 6600 ohms.

THE 3A5 H.F. TWIN-TRIODE

Filament	Coated		
Filament Arrangement	*Series**	*Parallel***	
Voltage	2.8	1.4	d-c volts
Current	0.11	0.22	amp.
Direct Interelectrode Capacitances:°			
	Triode Unit T_1	*Triode Unit T_2*	
Grid to Plate	3.2	3.2	μμf
Grid to Filament	0.9	0.9	μμf
Plate to Filament	1.0	1.0	μμf
Plate to Plate	0.32		μμf
Maximum Overall Length			2-1/8"
Maximum Seated Height			1-7/8"
Maximum Diameter			3/4"
Bulb			T-5-1/2"
Base▲			Miniature Button 7-Pin

Pin 1 – Filament –
Pin 2 – Plate T_2
Pin 3 – Grid T_2
Pin 4 – {Fil. Mid-Tap ((+ parallel)
Pin 5 – Grid T_1
Pin 6 – Plate T_1
Pin 7 – Fil. (+ Series)

BOTTOM VIEW (7BC)

RCA Socket — Stock No.9914
Mounting Position — Any

For convenience, one triode unit is identified as T_1; the other as T_2.

Maximum Ratings Are Design-Center Values

A-F POWER AMPLIFIER

Plate Voltage	135 max.	volts
Plate Current	5 max.	ma.
Plate Dissipation	0.5 max.	watt
Characteristics – Class A, Amplifier:		
Plate Voltage	90	volts
Grid Voltage	-2.5	volts
Amplification Factor	15	
Plate Resistance	8300	ohms
Transconductance	1800	μmhos
Plate Current	3.7	ma.

R-F POWER AMPLIFIER & OSCILLATOR – Class C Telegraphy

Key-down conditions per tube without modulation

D-C Plate Voltage	135 max.	volts
D-C Grid Voltage	-30 max.	volts
D-C Plate Current (per unit)	15 max.	ma.
D-C Grid Current (per unit)	2.5 max.	ma.
Plate Input (per unit)	2.0 max.	watts
Plate Dissipation (per unit)	1.0 max.	watt
Typical Operation At 40 Mc With Both Units In Push-Pull:		
D-C Plate Voltage	135	volts
D-C Grid Voltage •	-20	volts
	4000	ohms
	570	ohms
Peak R-F Grid-to-Grid Voltage	90	volts
D-C Plate Current	30	ma.
D-C Grid Current (approx.)	5	ma.
Driving Power (approx.)	0.2	watt
Power Output (approx.)	2	watts

*, **, °, •, ▲, ; see next page

The inter-electrode capacities are as follows:—

Grid to plate	3.6 μμf.
Grid to cathode	2.2 μμf.
Plate to cathode	0.7 μμf.

APPLICATION OF THE 7193

On account of its physical construction, this tube is especially suitable for application in circuits using transmission lines as circuit elements. It is not intended here to give sample circuits, since many suitable ones are to be found in text-books and in the general and amateur literature. The resonant frequency of the valve structure itself (*i.e.*, with the grid and plate connected by the shortest possible link) is 355 mc/sec., so that the maximum useful frequency as an oscillator or amplifier can be expected to be rather lower than this. However, the tube has been used in war-time equipment at frequencies in excess of 200 mc/sec., so that useful operation can be expected at frequencies as high as 250 mc/sec. if care is taken with the circuit design. The valve would make an excellent local oscillator for V.H.F. receivers, and is capable of being operated in this way with conventional tuned circuits at least up to 140 to 150 mc/sec. On account of the two top-caps for plate and grid respectively, the tube is easy to apply not only to open-wire line circuits, but also to butterfly and cylinder circuits, and at the appropriate frequencies will give stable and efficient operation with all these types of circuit.

When excellent valves like this are available at very low prices, it is worthwhile to remember that valves designed for V.H.F. will give much better than average performance at lower frequencies than do normal receiving types. For example, as a low-powered frequency multiplier in the range up to 50 mc/sec. and higher, the use of tubes such as this will give much better output and efficiency than will receiving tubes of comparable plate dissipation and characteristics. With its plate dissipation of 3.3 watts, the 7193 should give power outputs up to 9.9 watts if the efficiency can be maintained at 75 per cent., and 7.7 watts at an efficiency of 70 per cent. At a plate voltage of 300, and an efficiency of 70 per cent. the maximum D.C. plate current will be 36.6 ma.—a plate input of 11 watts. Should the valve be used as a class A amplifier, as, for instance, in a transformer-coupled A.F. circuit, the maximum plate current at 300 volts will be 11 ma., and the required bias will be —10.5 volts. The above figures for output and efficiency refer, of course to its use as a Class C oscillator or amplifier, and not as a frequency multiplier, because in the latter service, the efficiency will not reach 70 per cent., so that the plate input will have to be reduced accordingly.

* * *

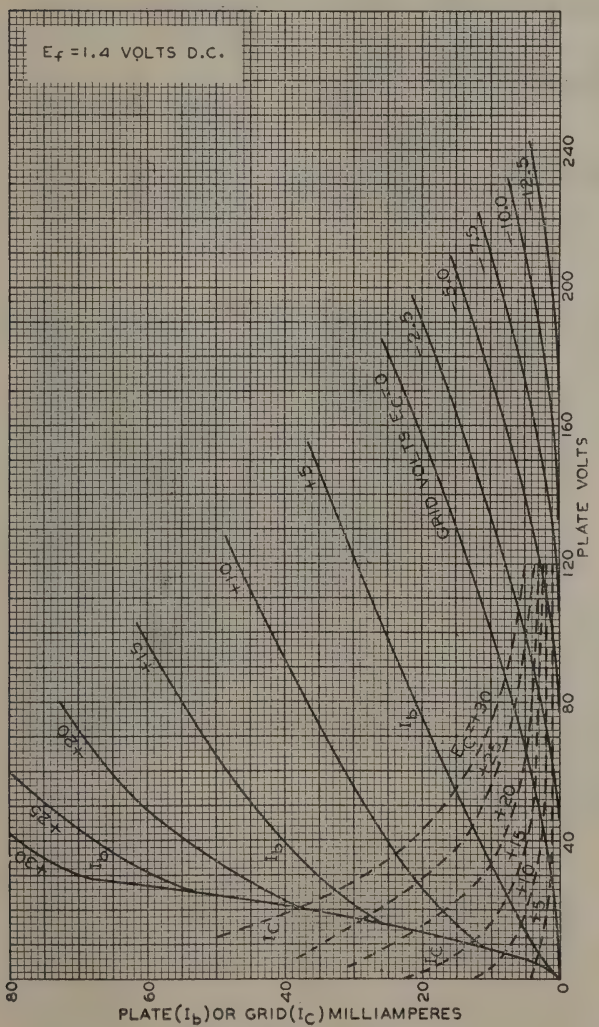
THE 3A5/DCC90 1.4 VOLT TWIN TRIODE

The second tube featured this month is the 3A5. It is not thought that these are available from war surplus, but the tube is a useful one which has a Continental direct equivalent, the DCC90. These valves are miniature types, and have been designed for use in battery-operated equipment requiring R.F. power amplifiers and oscillators. The detailed characteristics are given in the attached table, so that there will be no necessity to go into detail about them here. The tube is a very handy one where outputs of a few watts are needed from battery-power-supplied portable transceivers, etc., and has already been used in this journal as the basis of a stable push-pull R.F. oscillator to act as a self-excited transmitter for use in radio control work. The tube's usefulness is enhanced by the fact that it has three filament connections, enabling it to be used with filament supplies of 1.4 or 2.8 volts at will.

Unfortunately data on the maximum operating frequency is not available, but excellent operation has been

obtained on the 50–54 mc/sec amateur band, and there seems to be plenty of reserve at that frequency, indicating that satisfactory working would be obtained at considerably higher frequencies. This tube has been used as the transmitter in radiosonde balloons, at a frequency much higher than 50 mc/sec., and our own opinion (unfounded on practical work as yet) is that it would handle 150 mc/sec. with ease. Its dual construction makes it particularly suitable for low-powered transmitting circuits as (a) a neutralized push-pull Class C amplifier; (b) a push-pull frequency doubler; (c) a push-push frequency tripler; and (d) two separate stages of frequency doubling, one feeding the other. The applications of a tube like this are really limited only by the ingenuity of the user, and it should be a boon for many unusual applications where battery valves must be used. For multivibrators and wave-form generating circuits it should be ideal, and as useful in its own sphere as the versatile 6SN7 in A.C.-operated equipment.

PLATE CHARACTERISTICS OF 3A5



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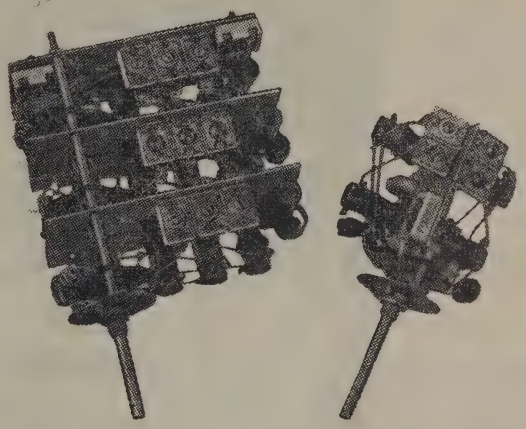

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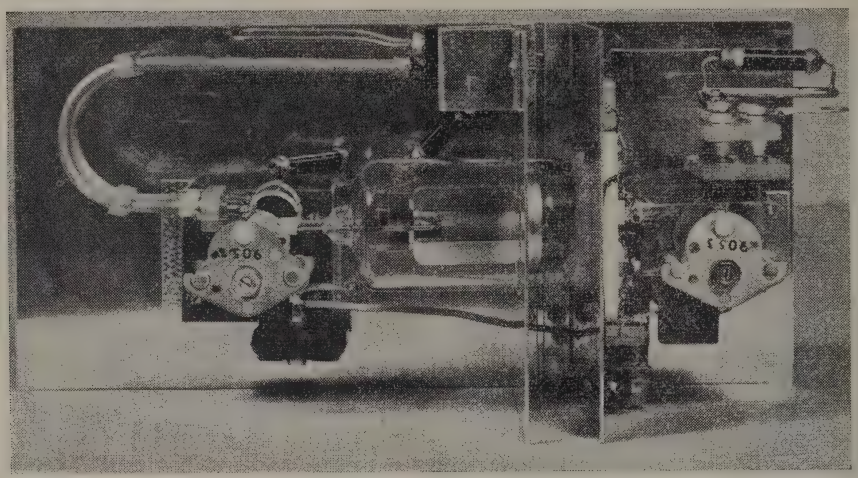
The PHILIPS Experimenter

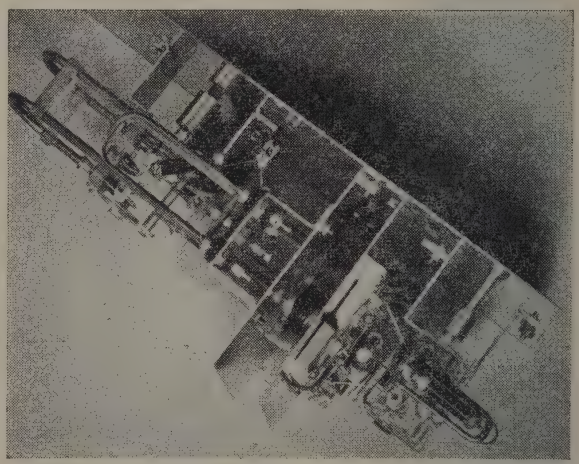
An Advertisement of Philips Electrical Industries of N.Z. Ltd.

No. 41: An Experimental Final Amplifier for Six and Two Meters



PART II
CONSTRUCTION

In using the circuit we have been discussing, it will probably be desired to build it into a complete rig, which will include the frequency control and multiplying stages, and this can be done without departing in any way from the recommended lay-out. However, so as not to confuse the issue, the stage using the Philips QQE06/40 has been built as a separate entity. If desired, those who wish to make it an integral part of a complete rig will be able to do so simply by making provision on the main chassis for fixing the unit, as described, as a removable sub-assembly. The main member of the construction is a small sheet of aluminium measuring eleven inches by five. This acts as a panel, and at the same time supports the whole of the rest of the structure. Supporting the valve socket, is a sheet of the same aluminium, 5 in. x 4 in. The hole for the valve socket is at the centre of this piece, and is 1⅝ in. in diameter. Spaced exactly an inch from this is a shield partition, of the same size as the sheet which holds the socket. At the centre of this second sheet is a hole 2 in. in diameter, giving ample clearance for the valve. The shield partition occurs at approximately the same position as the shield plate inside the valve itself, and forms a continuation of it, outside the glass envelope, but it also has a further function—that of supporting the bracket which holds the socket into which the "cold" end of the 2-metre plate line plugs. This bracket is bent from an inch-wide strip of aluminium, and is one inch high, and 1½ inches long. Of course, flanges are included to act as feet, and these are held to the shield partition by two nuts and bolts. Also on this bracket are the two sockets for holding the hair-pin coupling loop which is used for extracting the output power when the unit is on the 2-metre band. These sockets are not used in the six-metre set-up, so that they



can have the two-metre feeders permanently wired to them. Two other small brackets are needed to complete the metal-work. One of them supports the grid circuit's tuning condenser, and is also made from one-inch wide aluminium strip. It makes a platform 1⅜ in. high, to which the Polar split-stator condenser is screwed. These condensers have three bushes on the front plate, threaded to take 6BA bolts.

The remaining bracket is for mounting the plate tank condenser. It is of similar construction to that for the grid tuning condenser, but must be insulated from the chassis, so that in this case, the bracket is made of two

aluminium side-pieces, with a top platform of fibre sheet. The condenser is screwed to the fibre sheet, which measures 2 in. x 1½ in. The metal side-pieces hold the sheet of fibre 1¼ in. from the panel, and this brings the connecting lugs of the stators of the condenser exactly opposite to the plate pins on the Philips QQE06/40.

All the constructional parts described so far can be seen quite clearly in the photographs, one of which was taken directly behind the panel, and the other from almost directly above the whole unit. The only remaining mechanical work concerns the making of perspex strips to hold banana sockets for the grid coils and the plate coils. For the former, ⅛ in. or 3/16 in. perspex stock is used, and is cut to 1¾ in. long by 1 in. wide. Three banana sockets are mounted in a row 5/16 in. from one of the long edges, the spacing between them being ½ in. Then, at the other side of the strip of perspex, two more sockets are placed, again half an inch apart, but symmetrically disposed with respect to the centre of the other three sockets. These last two are connected to the input feeder line, and the grid coil unit, when plugged in, connects them to the coupling coil L_4. The perspex plate is made, and the banana sockets are installed in it. Then, with the grid tuning condenser turned so that its stator connecting lugs are uppermost, the outer two of the row of three sockets are soldered directly to the connecting lugs. There is thus no lead at all between the coil and the condenser of the tuned circuit, which greatly helps in realizing an efficient tuned circuit at high frequencies. Leads are run from the stator lugs to the grid pins on the valve socket, which will have been mounted with the fat cathode pin downwards.

The other perspex strip is 1½ in. long by ½ in. wide, as it has to support only three sockets. These are spaced in the same way as on the grid strip, and the outer two are similarly soldered to the stator lugs of the plate tank condenser, but this time so that with the condenser in the same position as the grid one, the banana sockets are placed horizontally instead of vertically. This can also be seen clearly in the photographs.

It should be noted that on the perspex strips, ordinary non-insulated banana sockets are used, the perspex being relied upon to provide the insulation to both R.F. and D.C. The already insulated Belling-Lee sockets should not be used here, as their insulating material is not very satisfactory for R.F. use. It will be seen, though, that on the metal bracket above the valve, where the sockets for the two-metre line are to be found, the Belling-Lee sockets *are* used. This is because they are here called upon only for D.C. or low-voltage R.F. insulation, and not for high-voltage R.F. purposes. Their use saves the necessity for making a third perspex strip, and is quite in order for the purposes described. The construction

(Continued on Page 42.)

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THE "R. & E." AMATEUR TELEVISION PROJECT

PART IV

A SUMMARY OF PROGRESS TO DATE

In the last instalment of this series, we described in detail the circuits that have been prepared, to act as the initial deflection unit for the cathode ray tubes. We do not intend to imply that the circuits used are the only ones that could be devised, or even that they are the best. Some readers will no doubt be surprised to find that they are so complicated, and use so many valves, but as was pointed out earlier, there is some virtue in using valves freely in unfamiliar applications. It is that very frequently, so-called "simple" circuits, which use only a small number of parts and valves, are in practice much more difficult to deal with than others which scatter valves about quite liberally. The reason for this is not hard to find. The circuit with many valves can be arranged in such a way that each valve has a separate and specific job to do. As long as each job and its purpose is understood, it then becomes a relatively simple matter to find out whether each valve is doing its work properly, thus making it very much easier to track down faults that may occur, or to make the initial adjustments necessary to put the gear, once built into proper operating condition. In circuits where several functions are embodied in the same valve, which may have a disarmingly small number of components associated with it, it is often exceedingly difficult to make the arrangement work properly should it not do so at first switching on. The trouble usually is that such circuits are difficult to understand, not only for the tiro, but often for the expert as well, so that it is sometimes a very much hit or miss affair when it comes to making things work properly. Also, should a fault develop, it can be exceedingly difficult to track down unless the defect is a simple one to find with ordinary test instruments, such as a multi-meter and a condenser-leakage tester. In addition, the circuit values in such composite arrangements are very often critical, in which case, they may not work, in spite of the complete absence of components that can be called really faulty.

As an example of how easy it is to make our own circuit work, supposing it does not do so at first, let us take a few imaginary faults, and see what their effects would be. This will have the added advantage of giving a few leads to those who may have built the circuit already, but not with the proper results.

SOME FAULTS AND THEIR EFFECTS

Suppose, for example, that the line time-base is running satisfactorily, but that there is no frame time-base. This will be obvious from a glance at the face of the cathode ray tube, to which the time-bases are attached. This illustrates one automatic advantage of TV equipment over ordinary receivers. It is that the TV set-up has its own built-in oscillopscope, with the result that many faults will become immediately noticeable from their effects on the pattern, and often, such faults will be partly, at least, localized simply by the appearance of the tube. Since the frame time-base is not working, the picture will revert to a single horizontal line. We can therefore completely ignore the line time-base and amplifier circuits for the time being, and concentrate on the frame circuit, which consists only of the multivibrator, the gas tube and the paraphase amplifier, the pulse amplifier being regarded as an extra. Now a simple test of the paraphase amplifier, by temporarily connecting a signal to the input grid, will tell whether this circuit is at fault. If no audio signal generator is available, one can use the 50 c/sec. heater voltage as a signal source by tapping a wire simultaneously on to the live heater terminal and the input grid of the amplifier. If the latter clearly is O.K., there are only the multivibrator and the gas tube to suspect. Next, the obvious thing to do is to see if the multivibrator is oscillating. To do this, the C.R.T. can be used as a 'scope by taking off the Y-plate leads from the amplifier output, and temporarily touching either of them on to one of the MV grids (NOT to plate, unless you have left the blocking condensers in the lead to the deflecting plates).

If a large deflection, almost off the screen of the tube is obtained, the MV is clearing working, and the trouble must lie elsewhere. Now unless the EN31 is itself defective, about the only things that can stop the circuit from operating if the MV is running are (a) no triggering voltage reaching the EN31 grid, and (b) too much bias on the EN31, or insufficient amplitude (voltage output) of the triggering pulse. In the first case, the trouble can only be due to an open coupling condenser between the multivibrator plate and the EN31 grid. (Note: If the condenser were shorted, the MV would not be working.) In the second, the cure will obviously be to reduce slightly the bias on the EN31. This can be done by decreasing the 10k. resistor in the cathode circuit of the EN31 slightly, or by increasing slightly the 75k. resistor connected to the H.T. line.

Now, since the mode of operation of the line time-base is similar to that of the frame time-base, similar faults in the two circuits will display similar symptoms, and there should be little difficulty in tracking down and curing any faults. It would be a good idea for anyone who is putting this gear together but who does not have a regular oscilloscope, to build as a separate piece a equipment, a simple self-running time-base of the sort used in oscilloscopes. Then, with this time-base, the cathode ray tube will become a test oscilloscope, simply by connecting the free-running time-base to one set of plates, and using the other set for examining the wave-forms throughout the deflection unit. The separate time-base, together with the usual multimeter, will be able to perform most of the necessary tests for the time-base unit, since the final criterion of its operation is the correctness or otherwise of the wave-forms it produces.

Now let us imagine some particular component failures, and try and estimate their effect on the 'scope pattern.

(1) Complete open-circuit of the 1 μf. condenser from plate to earth on the frame EN31.

This will leave only stray capacity across the plate circuit of the EN31. The EN31 plate will thus be able to reach full H.T. voltage in the very short time taken for the stray capacities to charge up. When the triggering pulse comes along, the gas tube will still conduct, causing the strays to discharge, so that the result will be a very quick charge—not linear, though—at the end of each discharge stroke. However, for the bulk of the time, the voltage at the plate of the EN31 will be steady, so that visually the effect will be much the same as if the gas tube were not there at all.

(2) Short-circuit in the 1 μf. condenser.

No frame output, and probably overheating of the 500k. plate resistor, unless this is 1-watt size or larger.

(3) Open-circuit of one of the 1 meg. grid-leaks in

the MV circuit.

This probably will not stop the MV from oscillating altogether, but will greatly reduce the frequency. This will show up as a very flickery raster, since the frame frequency will be well below the frequency at which flicker is imperceptible. It will also be extremely non-linear, which will be shown up by the raster being much brighter at the bottom than at the top. If the brightness is the other way about, it simply means that the frame time-base is running from bottom to top instead of from top to bottom.

(4) Only half the usual deflection on either of the axes.

This means that one of the amplifier sections in the corresponding circuit is completely inoperative. In each case, it must be the right-hand section, for with both amplifier circuits, there will be no output at all if the left-hand valve of the paraphase pair is inoperative.

(5) A black band running slowly (or quickly) over the raster from top to bottom or vice versa.

This is caused by 50 c/sec. hum from the mains or power supply getting to the control grid of the cathode ray tube. It could be due to a fault not connected with the time-base unit at all, for hum arising in the part of the circuit that feeds the C.R.T. grid will give these symptoms. If it runs from top to bottom, this means that the frame time-base is running slightly slower than 50 c/sec. If the other way, slightly faster. Should the band be stationary, it means the time-base is *exactly* on 50 c/sec. If the band runs slowly, the frequency difference is slight, and if fast, great. This is why it is not advisable to have the frame time-base locked hard to the 50 c/sec. mains, because then, part of the picture would be permanently blacked out should hum get to the C.R.T. grid. The hum may be due to a poor 6SN7 or 6AC7 in the blackout circuit.

There are many other manifestations that could be cited, but most of them are unlikely to occur at all, and the above list will give some idea of what to look for, should all not be well at the start.

AN UNFORTUNATE DISCOVERY

We said at the beginning of this Project, that some of the things we proposed to do were not at all certain to be successful, but that our primary intention was to try them, and see what happened. It was also stated that the whole progress of the experimental work would be set out in these articles, so that readers should have the benefit of all the experience gained—successful or otherwise. There is often a temptation—natural enough—to say little or nothing about one's failures, but in describing this Project, we are committed to so doing, and this is really a good thing, because it is just as important to know what does *not* work as it is to know what does. It often happens in scientific work that negative results are as important as positive ones, so that we have good precedent for telling all and sundry when and why an idea has come to naught.

The unfortunate discovery referred to is just this, that it is not possible, as we had hoped, to use the common green-screened cathode ray tube as the picture signal generator. The same by no means applies to the same tubes for use as the picture tube, because in this case, the feature of the tube which makes it unsuitable as a picture generator makes it rather better as a tube on which to show the final picture. The trouble is the long persistence of the image on the green-screened tubes. That is to say, if the electron beam impinging on the fluorescent screen material is suddenly cut off, then the brightness of the trace does not disappear altogether. It decays more or less gradually, depending on the material of which the screen is made. Now in the case of Phosphor No. 1, which is the screen material that gives the well-known green trace, the image lasts for several milli-seconds. Just how this will affect the picture is not easy to visualize unless the effect has actually been observed, but once seen, there is little doubt about it, and it will certainly not be forgotten! In order to see how it works, it is necessary to have a picture in the mind's eye of the complete system, from the camera tube (for want of a better term) to the receiving or picture tube.

Let us suppose that we have the raster on the camera tube, and for simplicity's sake, suppose that the "picture" we want to televise consists of a black horizontal bar. Being horizontal, the bar is parallel with the lines of the raster. Thus, all the lines *above* the black bar will be full white, while all those covered by the bar will not

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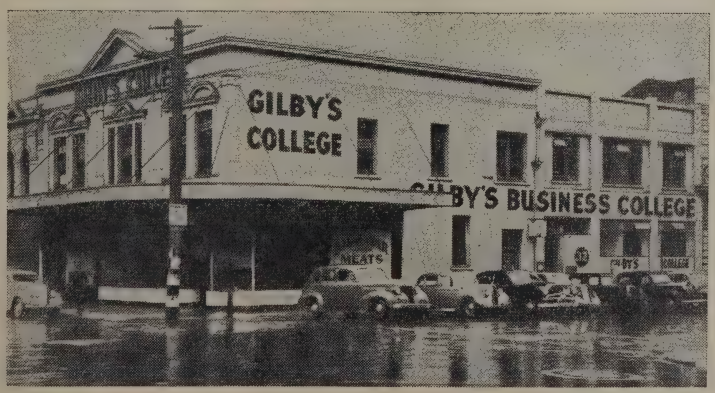

Wellingtonians and visitors to the Capital City will surely recognize the new premises of Giles & Elliott, who recently purchased the property owned by Symonds & Co., butchers, of Courtney Place, corner of Blair Street. The whole area includes 9,000 square feet of space. The shop front will be occupied by Radio Sound and Service (H. C. Dixon), and, except for the extensive basement to be used by Giles & Elliott for bulk stock, the rest of the new premises will be used as offices for Giles & Elliott administration. It should be noted that the premises at 9–11 Blair Street will *not* be vacated, and will continue to be used as a distribution store.

be seen at all by the photo-cell. The video output signal will therefore take up a very simple form—that of a pulse occurring during every frame, and lasting for a length of time which depends directly on the thickness of the bar, and therefore on how many lines it obscures. Since the pulse occurs once for every frame scan, its frequency will be 50 c/sec., the same as the frame frequency, and ideally should have absolutely vertical sides, and a perfectly flat top. Also, on the received picture, we should have a bar of exactly the same width as the original, and with perfectly sharp edges. When the photo-cell and video amplifier were connected, and a bar was tried across the camera tube, it was found that a bar of a kind was reproduced on the picture tube, but that instead of having both edges clearly defined, there was a gradual falling-off in the intensity of the trace at the upper edge of the bar, and a sharp clear edge at the bottom of the bar. This can easily be accounted for in the following way.

At the upper edge of the bar, the light output to the photo-cell is cut off by the bar, but because of the persistence of the screen, the cell is still receiving light from scanning lines that have passed earlier. Because of this, the cell gives output *in spite of* the bar across the screen of the tube, until such time as the light from previous lines has decreased to zero. Of course, the light from the previous lines decreases in brilliance, and the output of the cell gradually decreases until, at some time after the first line to be obscured by the bar, there is no output at all. The cell's output then remains at zero until the last scanning line to be covered by the bar occurs. Then, when the first scanning line below the bar appears, there is an instantaneous full light output, since there is no delay in the production of light by the screen, only in its disappearance.

If the wave-form of the video output is examined, it will confirm the above description by showing that a sort of square wave is indeed produced, but one with a very sloping leading edge, and a quick, vertical trailing edge.

WHAT CAN BE DONE ABOUT THIS?

The next question to exercise us, having discovered that the tubes with the P1 phosphor are useless for camera purposes, is that of finding a suitable tube that *will* work in the way we required. Fortunately there is a surplus tube, that has been available in New Zealand, and is still available in England, and possibly in Australia, too, that should perform in the required manner, since it has one of the very short-persistence light blue screens that used to be quite common. This is the VCR112. It is a five-inch tube, of rather unusual appearance in that some of its deflecting plates are not brought out to base pins, but to caps on one side of the glass neck. The idea of this was to make a tube that could be used for very high-speed (and therefore high-frequency) phenomena. The caps on the side, for connection to the Y-plates give the latter very short leads, and make the tube specially suitable for examining radio frequency waveforms. However, this is by the way, for we are concerned mainly with the characteristics of the screen. As yet we have not actually tried the VCR112 ourselves, but have heard from someone who is doing somewhat the same tricks independently, that it is quite successful. Those who are desirous of continuing along the same lines as we are, would therefore be well advised to try to acquire one of these tubes.

As for the remainder of the project, we have already

(Continued on Page 45.)

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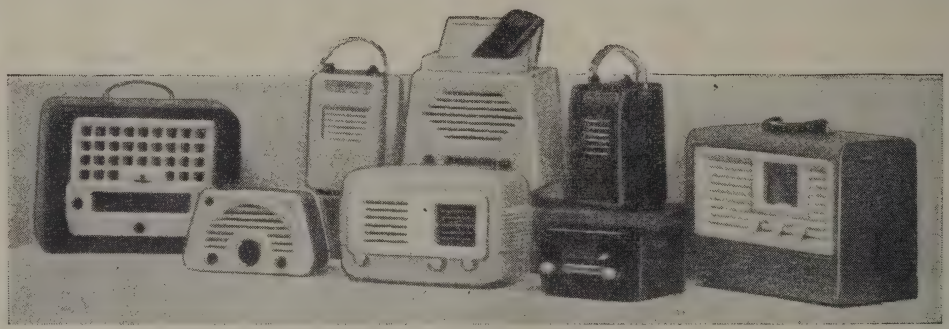

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AERIALS AND TRANSMISSION LINES

Two interesting departures from the standard TV aerials are: (a) A type of flopover array, which has four extended double Zepps, mounted in lightweight style. The flopover is worked by hinge and cord to pick up either horizontal or vertical polarization. (b) A Houston hayrake aerial with twelve elements with co-axial coupling.

—*QST* (U.S.A.), December, 1950, p. 42.

AUDIO EQUIPMENT AND DESIGN

A further study of loudspeaker cabinet design with special reference to sound-absorbent dampings strategically placed. Effective low frequency damping can be achieved by concentrating the absorbent material into one or two partitioners suitably placed across the cabinet.

—*Wireless World* (Eng.), November, 1950, p. 382.

Much disapopintment can be avoided by a simple understanding of the principles underlying the design and selection of input arrangements for standard 78 r.m.p. and 33 1/3 r.m.p. long-playing records. The matching of impedances for various types of pick-up heads is described.—*Ibid*, p. 386.

The advent of microgroove recording has made possible worthwhile home recording on discs. Lightweight pick-ups have reduced mechanical loading and new cutting heads have simplified procedure for the home-recorder. Some notes on technique are given.

—*Radio and Hobbies* (Aust.), January, 1951, p. 62.

ELECTRONIC DEVICES

A million-volt resonant cavity X-ray tube is described. The accelerating voltage is developed in a resonant cavity excited by a high-power magnetron operating at 25 cm. The focal spot is very small and as the output is pulsed the tube may be used as a stroboscope for the radiography of moving machinery.

—*Proceedings of the I.E.E.* (Eng.), Nov., 1950, p. 28.

MATERIALS, VALVES, AND SUBSIDIARY TECHNIQUES

Devices employing semi-conductors are finding increasing application in industry. This latest study deals with theory and practical application and the mathematics given are on a familiar basis.

—*G.E.C. Journal* (Eng.), July, 1950, p. 107.

The manufacture of quartz plates for frequency control requires extreme precision, and mass production is difficult. The article covers the methods used to achieve war production.

—*Philips Technical Review* (Holland), May, 1950, p. 323.

MATHEMATICS

Tolerances and errors. Many persons purchase components without any appreciation of what tolerances indicate. Some simple mathematics indicate the significance of tolerance variations, and the effect on the practical results.

—*Wireless Weekly* (Eng.), November, 1950, p. 403.

MEASUREMENTS AND TEST GEAR

A pulse generator is described suitable for the calibration of radio noise measuring sets and the study of the frequency responses of networks. It will reproduce pulses with a repetition frequency between 5 and 5,000 pulses a second.

—*Wireless Engineer* (Eng.) October/Nov., 1950, p. 265.

There is a demand for oscilloscopes which will deal with frequencies well above the 1 mc/sec. which is usually regarded as the maximum for saw-tooth voltages. The oscilloscope suggested works on the stroboscopic principle and synchronized pulses do the work of high frequency scanning circuits. The proposed device shows great promise for recording results far beyond the frequencies which might normally be expected.

—*Philips Research Reports* (Holland), June, 1950, p. 203.

MICROWAVE TECHNIQUES

The increasing use of frequencies above 30 mc/sec. needs crystals physically thinner than can normally be achieved. The article describes "overtone" crystals wherein the crystal is divided into planes which produce "overtones" and high frequency output.

—*Radio and Hobbies* (Aust.) January, 1951, p. 15.

PROPAGATION

The paper describes results of investigation to determine the effects of ignition interference with width modulated sync-pulse methods of transmitting television sound with a view to improving the quality.

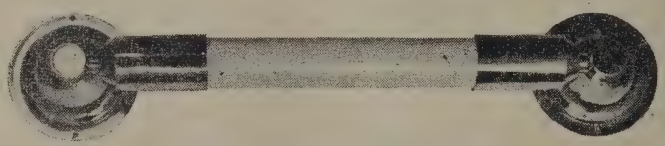
—*Wireless Engineer* (Eng.) October/November, 1950, p. 241.

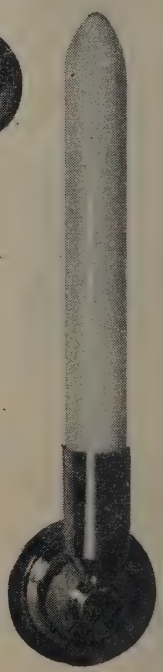
RECEIVERS

Variable filter tuning—the article describes various types of filter tuning and summarizes filter design for pi filter sections, T filter sections, and high-pass filters with consideration for hte overall radio freqeuncy response.

—*Wireless World* (Eng.), November, 1950, p. 393.

PANAMA...
CANDLE LAMPS





An Extra Sales Product for Radio Dealers

With the reappearance in New Zealand of the Opal Tubular Lamp, an attractive chromium-plated bracket type fitting is offered in the Panama Candle Lamp, combination 501 and 502.

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A method is described for automatic searching for R.F. signals combined with a system for automatically tuning the apparatus after sensing. The sensing circuit automatically changes to normal A.F.C. operation and the controlled oscillator locks in relation to the reference signal.
—*Proceedings of the I.R.E.* (U.S.A.), November, 1950, p. 1314.

Search for improvement in speech communication systems has lead to techniques using band-pass, clipping, filtering, and low-pass, high-pass frequency balance. The characteristics of these are outlined and the circuit is given of the clipper filter speech amplifier with details of construction and adjustment.
—*QST* (U.S.A.), December, 1950, p. 21.

TRANSMITTERS AND TRANSMITTING

Here is a further study in time deviation multiplex systems with a view to the effects on inter-channel cross-talk of the band-width characteristics of the transmission medium.
—*Proceedings of the I.E.E.* (U.S.A.), November, 1950, p. 1330.

Since the publication of the Taylor patent for a new form of modulation sometimes referred to as super-modulation, there has been speculation as to its merits. The system involves grid modulation, has certain advantages, but the limitations of the method are discussed with simple notes on theory, and a basic circuit is given for the super-modulation of a carrier.
—*QST* (U.S.A.), December, 1950, p. 38.

Communications on 460 mc/sec. The article gives the results of certain tests with mobile stations undertaken in the London area, and the general conclusion is drawn that frequencies in the band mentioned could be used for mobile services.
—*Wireless World* (Eng.), November, 1950, p. 412.

TELEVISION

This article deals with the report of a committee for applying television standards with special reference to methods of measurement of time-rise, pulse width, and pulse timing of video pulses in television.
—*Proceedings of the I.E.E.* (U.S.A.), November, 1950, p. 1258.

Regular reports on reception of the Alexandra Palace 41.5 mc/sec. sound channel have been send since March, 1949, to the B.B.C. from a station near Johannesburg. An analysis of these reports has been made which show very interesting facts, and that such reception is limited to certain months of the year varying with ionospheric conditions.
—*Wireless World* (Eng.), November, 1950, p. 407.

MISCELLANEOUS

This paper is a collection of data from solar observations and dealing with the question of "solar noise." There are described certain aspects of the sun's atmosphere from the point of view of electron density, electron temperature, and magnetic field as functions of height in the chromosphere and corona.
—*Proceedings of the I.E.E.* (Eng.), Part III, p. 477.

The Hall effect—some notes are given on what is known as the Hall effect which deals with current distribution in conductors in a magnetic field and without the field. The theory is applied further to semi-conductors, especially germanium, and an instrument is described for measuring variations of current and field.
—*Wireless World* (Eng.), November, 1950, p. 416.

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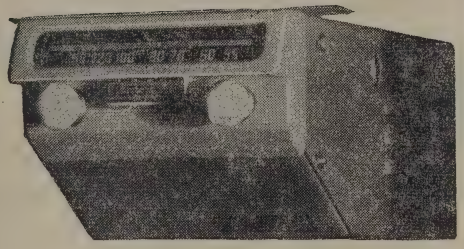

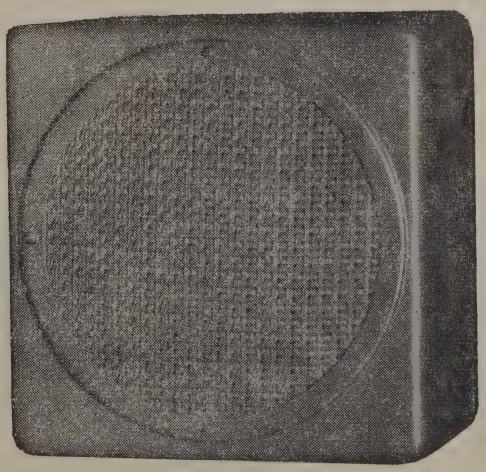

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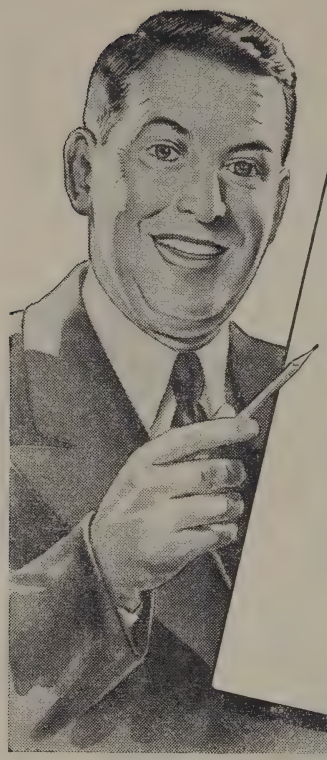

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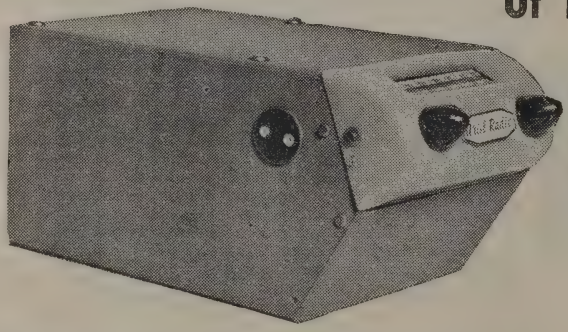

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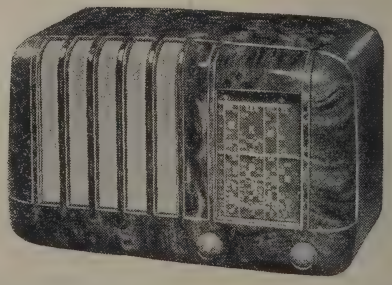

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Miniature Three

(Continued from Page 8.)

the detector, while the remaining $\frac{5}{8}$ in. hole is for the audio valve's socket. On the chassis front is a $\frac{3}{8}$ in. hole which takes the reaction control potentiometer, R_4. This hole is so placed that it comes in the centre of the front panel, but, owing to the cut-out which allows the A battery to be set in flush with the outside of the B battery, when the latter is placed against the side of the chassis, the hole is *not* in the centre of the front of the chassis. The main dial is centred on the hole for the potentiometer shaft, but is directly above it, so that if on the chassis drawing a line is drawn parallel to the sides, and passing through the potentiometer's mounting hole, this line will show the position occupied on the top of the chassis by the shaft of the tuning condenser. The latter is a midget two-gang type, and in the photograph looks as if it is all on the panel side of the shield partition. But what appears to be the second half of the gang is really a reflection of the front half. Actually, the shield partition is cut out so as to fit round the centre plate of the gang condenser, and the back section is hidden behind the shield in consequence of this. If the under-chassis photo is consulted, it will be noted that mounted right across the socket of the R.F. valve is a small partition. Its purpose is to shield the portion of the aerial and grid circuit that is under the chassis from the similar portion of the detector grid circuit (and R.F. plate circuit therefore).

In this view can be seen the four-pin Amphenol-type valve socket used for the aerial coil, the five pin socket for the detector coil, and the miniature ceramic R.F. amplifier valve's socket, with the shield across it. Also visible is the reaction potentiometer, the transformer used for L_5, the detector's ceramic socket, the phone jack, and a number of the small parts. The large condenser under the phone jack, and tucked into the corner of the chassis, is the electrolytic, C_9. Also to be seen are the leads out to the batteries, and the cut-out on the right-hand side of the chassis in which the A battery is fitted. The socket for the audio tube can be glimpsed at the left-hand side of the phone jack, with C_7 running between the plate pin of V_2 to the grid pin of V_3. Between the five-pin coil socket and the underneath shield partition can be seen the four-pin 2.5 mH. R.F. choke in the plate circuit of the R.F. tube. One end is connected directly to the plate pin of the tube's socket, while the other end is securely anchored to an insulated solder lug mounted on the chassis near the valve socket.

PERFORMING THE WIRING

In a set of this nature, the best results are obtained if the wiring is done by the shortest and most direct routes, except in cases where the length of a lead is of no consequence. In building any gear that uses valves, it is essential to know which leads must be kept as short as possible, and which can be made of any desired length. This knowledge alone can make all the difference between the gear working well or not at all, and is very worth-while knowledge to acquire. Partly it comes from experience, and partly from common sense, and as one's radio knowledge grows, so does one's innate "wiring sense," for want of a better term. For the newcomers (and be it whispered for some of the not-so-newcomers) here are the main rules to be watched.

(1) Leads carrying R.F. currents or voltages should be as short as possible.

(2) R.F. leads in the grid and plate circuit of the same valve should be as far as possible from each other as is consistent with (1) and should preferably be on opposite sides of a shield partition.

(3) Coils in the grid and plate circuits of the same valve should be shielded from each other, either by enclosing them in shield cans, or by the use of partitions or compartments built into the chassis.

(4) Bypass condensers should be connected as close as possible to the points which they are supposed to bypass, *e.g.*, C_6 in the present circuit, whose job it is to make the R.F. voltage at the plate of V_2 as small as possible without affecting the audio output voltage of the valve.

(5) If possible, it is desirable, but not always essential to make one point on the chassis (*e.g.*, a single solder lug) an earth-point to which are

(Continued on Page 45.)

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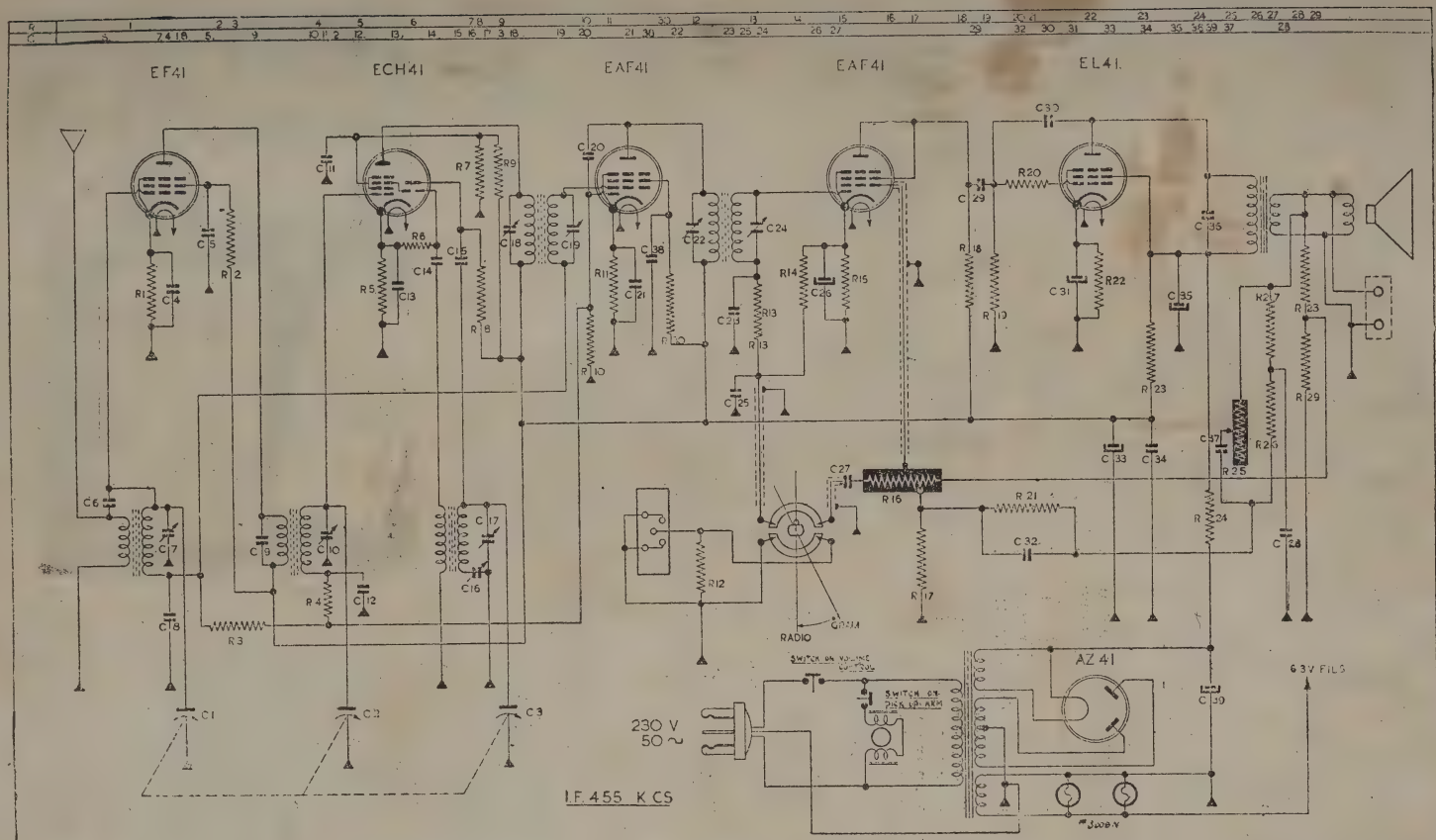


C 1 } Tuning condenser
C 2 }
C 3 }
C 4 .05 mfd. 400v. paper
C 5 .01 mfd. 400v. paper
C 6 3.9 mmfd. ceramic
C 7 3-30 mmfd. mica trimmer
C 8 .05 mfd. 400v. paper
C 9 100 mmfd. silver mica condenser
C10 3-30 mmfd mica trimmer
C11 .01 mfd. 400v. paper
C12 .05 mfd. 400v. paper
C13 .05 mfd. 400v. paper
C14 56 mmfd. ceramic
C15 250 mmfd. silver mica
C16 padder condenser
C17 3-30 mmfd. mica trimmer
C18 I.F. trimmers
C19 I.F. trimmers
C20 10 mmfd. ceramic
C21 .05 mfd. 400v. paper
C22 I.F. trimmer
C23 100 mmfd. mica cond.
C24 I.F. trimmer
C25 100 mmfd. mica cond.
C26 25 mfd. 25v. electro
C27 .05 mfd. 400v. paper
C28 .01 mfd. 400v. paper
C29 .01 mfd. 400v. paper
C30 100 mmfd. mica cond.
C31 25 mfd. 25v. electro
C32 .02 mfd. 400v. paper
C33 20 mfd. 400v. electro
C34 .25 mfd. 400v. paper
C35 40 mfd. 400v. electro
C36 .005 mfd. 600v. paper
C37 .02 mfd. 600v. paper
C38 .01 mfd. 600v. paper
C39 40 mfd. 400v. electro

R 1 300 ohms ½ w. carbon
R 2 100 K. ½ w. carbon
R 3 2.2 meg. ½ w. carbon
R 4 2.2 meg. ½ w. carbon
R 5 180 ohms ½ w. carbon
R 6 22 K. ½ w. carbon
R 7 60 K. ½ w. carbon
R 8 25 K. ½ w. carbon
R 9 30 K. ½ w.
R10 1 meg. ½ w.
R11 300 ohms ½ w.
R12 22 K. ½ w.
R13 60 K. ½ w.
R14 1 meg. ½ w.
R15 3,900 ohms 1 w.
R16 2 meg. control with tap and switch
R17 22 K. ½ w.
R18 100 K. 1 w. carbon
R19 .5 meg. ½ w.
R20 22 K. 1/3 w.
R21 220 K. ½ w.
R22 150 ohms 1½ w.
R23 2,200 ohms wire wound
R24 2 x 1,800 ohms 4 w. carbon
R25 .5 meg. tone control
R26 60 K. ½ w. carbon
R27 6,000 ohms ½ w. carbon
R28 100 ohms ½ w. carbon
R29 28 ohms ½ w. carbon
R30 100 K. ½ w. carbon

THE NEW ZEALAND ELECTRONICS INSTITUTE (Inc.) NEWSLETTER

BRANCH NEWS: DUNEDIN

Dunedin Branch members recently visited 4YA where the new 10 KW transmitter is at present being installed. This visit was made possible through the courtesy of Mr. L. Halchrow, Chief Radio Engineer of Station 4YA. To assist those present to follow the intricacies of this installation a schematic wiring diagram was made available and members had the assistance of a helpful staff to explain any parts of the installation.

The convenient construction of this up-to-date transmitter and its many attractive features caused much favourable comment from the members, who spent two hours inspecting the station. The new transmitting mast was explained in detail.

At the conclusion of the inspection a hearty vote of thanks was passed to Mr. Halchrow for his consideration and courtesy in making the inspection of this radio equipment possible.

A further innovation for Dunedin was a visit to the m.v. *Port Wellington* on 25th January, 1951. Mr. French, Chief Radio Officer, briefly explained and demonstrated firstly the Marconi "Oceanspan" radio transmitter. This transmitter of 100 watts is an all-wave job and is housed in an attractive metal cabinet of very modern design. Associated with it is a Marconi all-wave receiver. This type of receiver is rather unique in that the intermediate frequency is changed from 100 kc/sec. to 570 kc/sec. when the wave change switch is operated, so that all-wave coverage may be obtained without the receiver frequency coinciding with the I.F. frequency. The 100 kc/sec. I.F. is used on the low frequency bands and the 570 kc/sec. I.F. is used on the high frequency bands; this has the additional advantage of giving better image rejection on the high frequency bands.

After members had acquainted themselves with all the gear in the ship's radio room, the party adjourned to the chart room. Mr. French first of all opened up the radar cabinet to let those present see the internal arrangements of the radar equipment. The book-of-words was also produced so that members could study the circuit. Mr. French then explained and demonstrated the starting of the power supply and the voltage regulating of the power supply. After displaying the cupboard of spare gear, he started the radar up with all the drawers in the open position, and immediately, a radar picture of the lower harbour appeared on the 10 in. cathode ray tube. This tube seemed to be a bit eccentric but, nevertheless, members were able to get an idea of the principle of operation and the harbour picture was inspected at various range settings from 2,000 to 60,000 yards.

The visit having been arranged originally to inspect the radio and radar gear, those present were pleasantly surprised on being invited by the Chief Engineer to inspect the motor room. Most of us had never seen such gigantic internal combustion engines, and everybody was surprised to see that they were of fabricated construction and not castings. We also had an opportunity of seeing all the auxiliaries in the motor-room, and then adjourned to inspect the refrigeration department of the ship. This also was very interesting to most of us.

On returning to the radio room a vote of thanks was passed to Mr. French, the Captain, and Officers, and the party then returned to town.

GENERAL NEWS

Now that the holidays are over it is hoped that Branches will resume their activities and members will be kept informed regarding such matters per medium of this newsletter. Pending receipt of additional details of Branch activities it is felt that members would appreciate further information respecting television. An article has been received in a letter from the Reciprocal Trade Federation of the United Kingdom covering the first display in Berlin of television.

PYE SHOW FIRST TELEVISION IN BERLIN

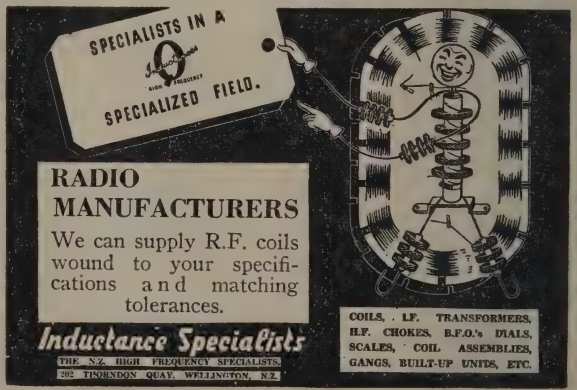
Early in October last the Pye Company had the honour of representing the British Television Industry at the Berlin Industries Fair, and of showing television to the people of Berlin for the first time!

The Fair itself was an exhibition of German industry, but Great Britain, as well as the United States of America, France, Belgium, and the Netherlands were all represented by their respective national pavilions. The Pye Company was asked to lend the studio transmission equipment for the television demonstration in the British pavilion, and seven other British manufacturers—including the Pye Company—were invited to show their receivers in the "Television Avenue." A team of Pye engineers flew from Cambridge Airport direct to Berlin with the equipment and receivers for the show. This team was supported by the B.B.C. producer, Mr. Eric Fawcett, as well as engineers and cameramen. On arrival in Berlin, the TV transmission equipment was installed in the Jerboa Cinema, the stage being used as a studio, and for the demonstration the pictures were relayed by cable to the display hall in the British pavilion.

The pavilion was in the Exhibition grounds, and more than one-third of its area was occupied by the "Television Avenue" which formed the main attraction of the British exhibit, and, in fact, of the whole fair.

In his speech at the opening ceremony Sir John Freeman, Parliamentary Secretary to the Ministry of Supply, Great Britain, said that the British were the only nation to show a working television exhibit.

To the people of Berlin this demonstration was a novelty of great interest, and according to official records more than 250,000 people—including large numbers from the Eastern Sector—visited the show. However, the pressure of the crowds was so great that the crash barriers were broken, thus limiting the number of viewers only by the capacity of the "Television Avenue." On one occasion the excitement was so great that hundreds of Berlin police had to be called in to control a crowd of more than 100,0000 which tried to storm the British pavilion in an endeavour to see the television.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RADIO MANUFACTURERS
We can supply R.F. coils wound to your specifications and matching tolerances.
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THE N.Z. HIGH FREQUENCY SPECIALISTS.
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COILS, I.F. TRANSFORMERS, H.F. CHOKES, B.F.O.'s DIALS, SCALES, COIL ASSEMBLIES, GANGS, BUILT-UP UNITS, ETC.

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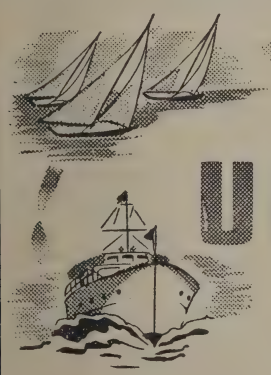

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A.C. *and* VIBRATOR OPERATED

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Perfect reception. Operates on 6-volt car battery or normal A.C. Mains.

Wine or green crocodile finished cabinets. "Easy Grip" carrying handle.

£37/12/6

Manufactured by

RADIO (1936) LTD. Auckland

ULTIMATE

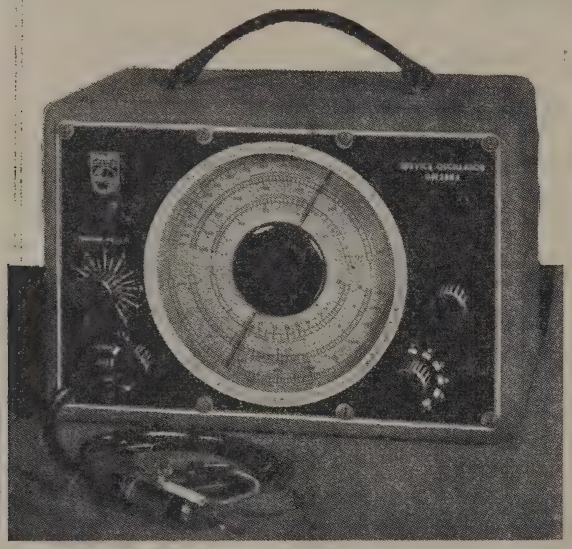
NEW PRODUCTS: LATEST RELEASES IN ELECTRICAL AND ELECTRONIC EQUIPMENT

This section of our paper is reserved for the introduction of new products and space preference is given to our regular advertisers. Advertising rates are charged according to space occupied. For further particulars contact Advertising Manager, R. and E., Box 22, Government Buildings, Wellington.

PHILIPS H.F. SERVICE OSCILLATOR GM2884

Application

This relatively stable H.F. oscillator is intended for use in the radio service workshop for trimming and testing receivers.



Description

The apparatus is provided with an oscillator circuit which by switching over the self-inductance and accompanying coupling coil can deliver a frequency variable between 100 kc/sec and 25 mc/sec, divided into six ranges. For each of these ranges there is a separate scale on the tuning escutcheon, having a diameter of five inches.

The H.F. voltage is conducted to the receiver being tested via a low-capacitance screened cable to which the dummy aerial is attached. The voltage can be regulated between 0 and about 100 mV by means of a step attenuator and a continuous voltage control with which the mains switch is coupled.

The H.F. signal is modulated about 30 per cent. with the aid of a built-in 400 c/sec. oscillator.

In a special position of the step attenuator only the A.F. signal (variable between 0 and 5v) is conducted to the output cable and can thus be used for testing A.F. amplifiers.

Frequency Ranges

A	100	kc/sec.	to	250	kc/sec.
B	250	kc/sec.	to	600	kc/sec.
C	600	kc/sec.	to	1.5	mc/sec.
D	1.5	mc/sec.	to	4	mc/sec.
E	4	mc/sec.	to	10	mc/sec.
F	10	mc/sec.	to	25	mc/sec.

The ranges amply overlap each other.

Frequency Accuracy

After the apparatus has reached its working temperature the error in frequency is ± 1 per cent., except for the very lowest side of the frequency ranges: 1.5 per cent.

Frequency Stability

With a 10 per cent. mains voltage fluctuation the frequency remains constant within 0.2 per cent., except in range A: 0.5 per cent. Variation of the load does not affect the frequency.

H.F. Output Voltage

This is asymmetrical and variable between 0 and 100 mV by means of a step attenuator with positions x 1, x 20, x 500, x 10,000 and a continuous voltage control. Up to 2 mc/sec. the attenuator is accurate to within 15 per cent.

Modulation

The H.F. signal is modulated 30 per cent., with 400 c/sec., ± 20 per cent. The modulation can be switched off. In the fifth position of the step attenuator the L.F. signal is laid on to the output cable and can be regulated with the votlage control between 0 and 5v. (± 20 per cent.). Distortion is less than 10 per cent.

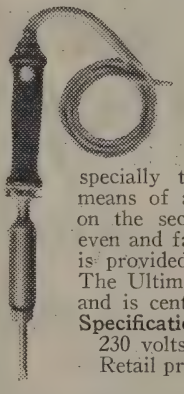
Dimensions

Length, 10 in. Width, 7½ in. Height, 7 in. Weight, 12 lb. The apparatus is contained in a light grey damask enamelled casing with a leather carrying handle.

Available ex stock from Philips Electrical Industries of New Zealand Limited, Auckland, Wellington, Christchurch, and Dunedin.

* * *

ULTIMATE ELECTRIC SOLDERING IRON



The illustration shows the new Ultimate electric soldering iron especially designed for heavy duty work and for the radio service shop. The iron is heavily nickel plated, has a steel body and a black enamel wooden handle. The ⅜ in. diameter copper bit with specially tapered head is easily replaced by means of a locking nut. The element is built on the section suspension principle and gives even and fast heating. Insulation of the element is provided by an anti-shock porcelain bobbin. The Ultimate iron is equipped with a flex grip and is centre balanced to prevent user-fatigue.

Specifications:

230 volts, 100 watts; Weight, 1 lb. 4 oz.

Retail price: £3 10s.

* * *

NEW "BYER INDUSTRIES" RECORDING EQUIPMENT

Further sound equipment from Byer Industries Pty., Ltd., Aust., per Swan Electric Co., Ltd., is announced as follows:—

R.33 Portable Recorder and Playback Unit

R.33 has two recording and playback speeds—78 and 33⅓ r.p.m. A single head, with excellent frequency response, performs both cutting and playback operations—plays ordinary commercial recordings, too! R.33 cuts records of high quality up to 12 in. in diameter at standard or microgroove pitch. The amplifier is of original and progressive design. It has been built by engineers for engineers and men who recognize superior technical

(Concluded on Page 45.)

CRESSALL

ASBESTOS WOVEN WIRE RESISTANCE NETS

COST SO LITTLE
& HELP SO MUCH

These products were described under New Products section of this magazine, February, 1951. Write or telephone for further details, and technical advice if required.

Stocks available from

Bradley's Electrical Co. Ltd.

57 Victoria Street, Wellington

New Zealand Distributors for
The Cressall Manufacturing Co., Ltd.,
Birmingham, England.

ERSIN

"The finest cored solder in the world."

MULTI-CORE SOLDER

Containing 3 cores of non-corrosive Ersin flux.

The 7 lb. REEL Ideal for the Radio Serviceman . . . saves time and increases efficiency.

●

13 S.W.G. 45/55% tin / lead alloy high-quality radio solder.

●

Ask your local Radio Dealer.

New Zealand Distributors:
GILES & ELLIOTT LTD.
9–11 BLAIR ST., WELLINGTON
Telephone 54-695 Telegrams: "RADOGEN"

UNDENIABLE BARGAINS IN WAR SURPLUS

FRACTIONAL COST PRICES. BEST ARMY QUALITY. STOCKS EBBING FAST.

AMERICAN CABLE. Does not meet with N.Z. 230v. house-wiring regulations, but there are dozens of uses to which it may be put.

Cat. No. E.W.57, 17 A.W.G. V.I.R. Braid, equivalent for 1/044 "Anaconda" U.S.A. 500 ft. coils— 3d. yd. or 10/- per 100 yds

Cat. No. E.W.58, 7/.0245 V.I.R. Braid; red only; American equivalent for 3/036; manufactured by Walker Bros., U.S.A.; 500 ft. coils— 4d. yd. or 15/- 100 yards

ARMY MORSE KEYS, perfectly made, platinum contacts. EX1075— 5/11

HEADPHONES, DYNAMIC, ex-Army; new. EX1065— 9/11

I.F. TRANSFORMERS; new; 465 k.c.; unsurpassed quality.

Cat. No. EX1006, 1sts — 7/11

Cat. No. EX1007, 2nds— 7/11

THROAT MICROPHONES — English Army surplus; new; in original cartons; ideal for contact mikes for guitars, etc.
Cat. No. EM180— 14/11

MATCHING TRANSFORMERS for above.
Cat. No. ET725— 7/6 each

Z.C.1 MIKE TRANSFORMERS (Type T117) (out of cans); new; excellent price.
Cat. No. EX1231— Only 5/6 each

MICROAMMETERS, 0-500 D.C.; Ferranti; 2¼ in. round. Cat. No. EM24— 24/11

R.F. METER, 0-100 ma.; Weston; 2½ in. round; thermo-coupled. Cat. No. EM23— 29/11

MODULATION CHOKES; cans 2 in. high by 3 in. between mtg. holes; lug type connection; suitable 6V6 plate circuit, etc.
Cat. No. EX1011— Only 5/11

METER RECTIFIERS; 5 ma.; copper oxide; new. Cat. No. EM45— Now 8/6

WRITE NOW **"THE LAMPHOUSE"** **11 MANNERS ST. WELLINGTON**

TRADE WINDS

Mr. A. J. Wyness

Shortly to leave for an extensive business trip to United Kingdom, Australia, and America is Jack Wyness, director of H.M.V. (N.Z.) Ltd. His purpose is to endeavour to improve the supply position for the various products handled by his organization in New Zealand and make investigations of the possibility of extension of trading lines handled by the several organizations abroad with whom H.M.V. (N.Z.), Ltd. are closely allied. Mr. Wyness also intends to obtain some first-hand knowledge of the television possibilities for New Zealnd—a matter which will, no doubt be of some considerable interest to his associates abroad.

Many changes in duties of the personnel of this company have recently taken place. In a personal interview with one of the Directors, R. and E. has been advised that the reorganization is entirely due to the effort to keep up with the increased amount of New Zealand business activity owing to the ever-increasing developments of the parent company in London.

Some of the staff changes are:—

Mr. L. H. Wright is relinquishing his position as Radio Factory Manager and will be taking a new position as Manager in the Company. The Radio Department will be divided up and controlled under the joint management of Mr. J. Short, who will be in charge of the office and production planning, and Mr. Con Bowie, who will be in charge of factory production.

Mr. J. McGregor in future will be specially looking after copyright problems, advertising, and musical sundries.

A new special equipment department which will be controlled by Mr. G. Waddell, who will handle the sale of recording blanks, all types of recording equipment, both domestic and commercial, office recording equipment, and other specialized equipment which the company makes available to us from time to time.

It is the intention of H.M.V. in New Zealand to make available at a later date to the radio trade, a special course which has been started in England by E.M.I. Studios, on television, details of which should be available later on.

* *

Mr. Kevin Clark, Manager of Wm. J. McLellan and Co., Pty., Sydney, factory representatives and distributors for "I.R.C." Australia, is expected in New Zealand early in March. Mr. Clark will tour New Zealand in company with Mr. Ken Stephens of Messrs. H. W. Clarke (N.Z.), Ltd., who act as New Zealand representatives for I.R.C. The itinerary is expected to reach Auckland on 11th March, then to Waihi on 15th March, returning to Wellington on 20th March. Mr. Clark will leave New Zealand on 27th March.

Accompanied by his wife, Mr. Bernie Giles, Managing Director of Giles and Elliott, is expected to leave in April for a trip to the United Kingdom extending over six months.

* * *

Mr. J. W. Robinson (Robbie) is now in Wellington looking after Wellington territory for Westco Products.

* * *

Mr. Herb Wilson has recently completed a tour of the South Island and Wellington for Webbs Radios. Other visitors to Wellington include Mr. Clifton Lewis from Auckland and Mr. Tom Spencer from Waihi.

* * *

Friends of Mr. Noel Souper will be glad to learn that he is back on the job after a spell in hospital.

* * *

R. and E. suffered some inconvenience recently when arriving for the start of a fresh day the staff met flows of water from their premises. It appeared that a fire in an adjoining office was only saved from spreading by the prompt action of a policeman, who, seeing smoke coming from windows, promptly called the fire brigade. Our thanks go to the many who made kind inquiries as to our welfare on this occasion.

* * *

Fire beneath the Collier and Beale premises in Wellington was another radio diversion. As in the case of R. and E.'s experience, only the prompt atention of a staff member, who was in the building, and the excellent work of the Wellington Fire Brigade saved a complete burn out.

(Continued on Page 42.)

29 DIFFERENT RECTIFIER TUBES
Now Replaceable
with S.T.C. Miniature Radio Rectifiers
IT'S STRONGER
IT'S CHEAPER
LASTS LONGER
RUNS COOLER
SAVES SPACE
AN STC PRODUCT
Write 'phone or call the Sole N.Z. Agents
STANDARD TELEPHONES & CABLES PTY. LTD.
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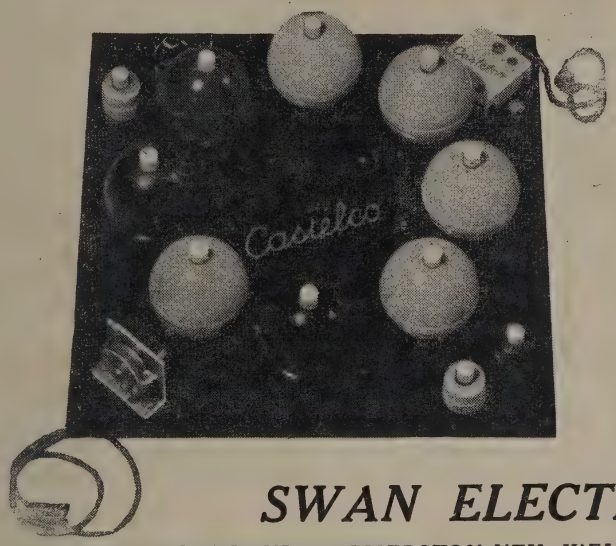
Christchurch Box 983 Wanganui Box 293

"CASTELCO" PRODUCTS



PUSH-BUTTON SWITCHES, for Table Lamps, etc.; 2 amps. 250 volts; small in size, neat design.

PENDANT SWITCHES AND PUSHES. A.C. and D.C. (make and break); 2 amps. 250 volts.

CORD PULL. Flush Rotary Switches, for wall fittings, etc.; 2 amps. 250v.; height 15/16 in.; width 1 in.; depth (inc. switch base) 11/16 in.; durable nylon cord.

SPRING RETURN SWITCHES, for Bells, Refrigerators, Cocktail Cabinets, etc.; 2 amps. 250 volts.

All the above are available in cream-white, ex stock.

Also available

CASTELCO MULTI-PURPOSE ON-OFF SWITCH; foot-operated; positive action; for stage lighting, photographers, laboratories, etc.

Write for full details to—

SWAN ELECTRIC CO. LTD.

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INCREASED INDUSTRIAL ACTIVITY

Railway Wagons Busier Than Ever

To meet the unprecedented demands of New Zealand industry the railways need more and more wagons every day. Pre-Christmas traffic, six per cent. greater than in 1949, continues to increase and from now on, some forty thousand wagons each week will have to be loaded and sent away.

Wagon-users are assisting by loading and unloading wagons promptly, and when necessary, at week-ends.

Continued Effort is Vital—Keep It Up!

The Philips Experimenter

(Continued from Page 25.)

described so far shows how, with the simple addition of a second R.F. choke for the H.T. plate feed, either the six-metre coil, or the two-metre line can be plugged in, without any circuit changes having to be made. When, as shown in the photographs, the two-metre line is in use, the centre of the three sockets on the plate strip is not used. It remains connected to the H.T. line through an R.F. choke, however, while the socket on the top bracket, into which the short-circuited end of the line plugs, is also connected to H.T. by a second R.F. choke. In this way, the valve receives its H.T. voltage whichever circuit is plugged in. Although not shown, it would have been possible to put an extra two banana sockets on the perspex strip for the plate circuit, making it identical to the one in the grid circuit. In this case, a permanently-connected coupling loop for six-metre output could be provided on the plug-in plate coil.

The rest of the wiring requires little comment. The 0.005 μf. mica screen bypass condenser can be seen attached to the rotor wiper of the grid tuning condenser, while behind it, and attached to the same wiper is the mica cathode bypass condenser. The filament bypass condensers are earthed directly to the chassis on which the valve socket is mounted, and can be seen above and below the valve socket in the photos. Below the plate-circuit bracket can be seen the 0.0005 μf. 1500v. mica bypass condenser, with one end connected directly to the rotor wiper of the plate tank condenser, and the other end tied to one of the mounting bolts of the bracket.

(To be concluded.)

Trade Winds

(Continued from Page 40.)

PUBLICATIONS RECEIVED

Kelvin Hughes, Marine Radar Type 2 Specifications (Marine) Ltd., per A.W.A., Wellington.

Inductance Specialists, Ltd., catalogue for 1951–52.

Green and Cooper, descriptive sheet, Simon Symphonic Tape Recorder.

Bradley's Electrical Co. Ltd., catalogue sheets covering "Cressall" Asbestos Woven Resistance Nets, Rheostats and Potentiometers, Sliding Resistances. Radial Type Dimmers, Shunt Field Regulators.

C. and A. Odlins, Ltd., catalogue Mullard Electro-Acoustic Products.

Central Office of Information, London, technical notes covering, One-hand Electric Soldering; Gas-tube Electric Ammeter; Flexite F.M. Transmitter Receiver; Valve Cheats Gravity; Bulk Viscosity Measurement.

Emidisc

TRADE MARK

LACQUER RECORDING BLANKS

The "Emidisc" lacquer recording blank fulfils the requirements of the most exacting standards of Broadcasting Authorities, Film and Professional Recording Studios. It may be used with confidence by the critical professional recording engineer and by the owner of the most modest equipment.

Accurate engraving to the limits of the recording equipment is ensured by these essential qualities and characteristics.

- SUPERIOR UPPER FREQUENCY RESPONSE. Will record up to 20,000 c.p.s. with appropriate recording equipment.
- LOW NOISE LEVEL. Average figures: — 45 db. ref. level 1 cm. per sec. velocity; — 63 db. ref. level 8 cm. per sec. velocity. (Cut at 78 r.p.m., 9½ in. diameter using sapphire cutter with 16 micron bevel.)
- ANTI-STATIC. Easy swarf clearance with brush or low-power suction systems.
- LACQUER THICKNESS constant over whole recording area.

Buchmann & Meyer pattern of a gliding tone, 20 Kilocycles to 25 cycles recorded by E.M.I. Studios Ltd., on an Emidisc blank.

- GOOD WEARING QUALITIES.
- PROCESSING: Mirror-like surface ensures ideal condition for processing (on appropriate sizes of blanks).
- PACKED IN HERMETICALLY-SEALED METAL CONTAINERS. Ensures good shelf life and protection. 10 in. sizes and upwards have individual air separation of blanks.

Write for particulars to—

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Types and sizes available for all purposes.

GREEN LABEL "Standard" selected direct recording blank: 6, 8, 10, 12, 16 in. sizes.

YELLOW LABEL "General Purpose" direct recording blank: 10, 12, 16 in. sizes.

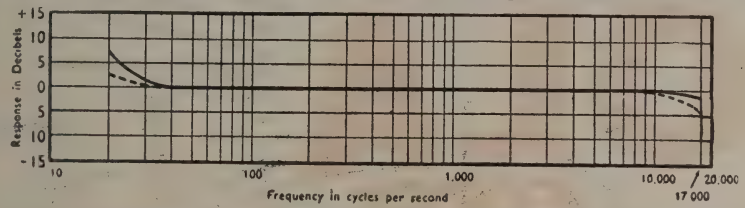
PLAIN LABEL "Audition" direct recording blank for experimental and general testing work: 10 in. and 12 in. sizes.

HIS MASTER'S VOICE (N.Z.) LTD.

G.P.O. BOX 108 . . WELLINGTON, C.1

BRIERLEY PICK-UPS

The JB/P/R Pick-up has been designed with the sole object of obtaining as realistic reproduction from gramophone records as possible with negligible wear of records. The real test is a listening test and not specification data, and, provided the recording and the rest of the equipment are of a sufficiently high standard, the results obtained are such that it can be difficult to realize that one is not listening to an original performance.



Dotted Line refers to Ribbon Pick-up Full Line refers to Armature Pick-up
Response Curves include Coupling Transformers
Correction has been made for low-frequency Attenuation in Test Record

Specification of Brierley Ribbon

Point: 80 times longer wearing than sapphire, ground and polished to an accuracy of 0.00002 in.
Total Mass of Moving Parts: 17 milligrams.
Effective Mass at the Point of Moving Parts: 4 to 5 milligrams.
Downward Pressure on Record: one-eight of an ounce.
Magnet Alloy: Alcomax.
Low-frequency Resonance: 5 c/s. (approximate).
Output Voltage: 0.0075 to 0.01v. R.M.S. (measured across secondary of Coupling Transformer with ¼ megohm load).
No measurable upper resonance.
Vertical compliance.

Provision is made for vertical motion of the point to minimize so far as possible defects due to the "pinch" effect. The Pick-up is quite robust, and there is no possibility of damage occurring from normal use; accidental dropping on to the record surface will not cause any damage.

WRITE FOR PAMPHLETS

RADIO REPAIRS LIMITED.
7A GREAT NORTH ROAD :: :: :: AUCKLAND

Beacon Technical Topics No. 29

MULTIMATCH MODULATION TRANSFORMER

A new modulation transformer rated at 10 watts has been added to the BEACON multimatch series. It is felt that this will be a very useful addition to the range, particularly for those concerned with mobile communication equipment.

BEACON, of course, make smaller transformers in considerable quantities for manufacturers of mobile radio apparatus. However, an all-round, useful, robust transformer for general purpose work will meet many needs. Tests on the new 10-watt multimatch transformer show that it will give excellent performance and it is offered to amateurs and professionals with every confidence.

Cat. No. 50 M 07

Audio Power: 10 watts.

Maximum modulator plate current per tube: 50 ma. or 100 ma. depending upon connections.

Total permissible Class "C" plate current: 50 ma. or 100 ma.

BEACON RADIO LIMITED

32 FANSHAWE STREET, AUCKLAND, C.1

MANUFACTURERS OF DRIVER AND MODULATION TRANSFORMERS, Etc.

If you are not served by one of the Wholesale Distributors mentioned below, please get in touch with us direct.

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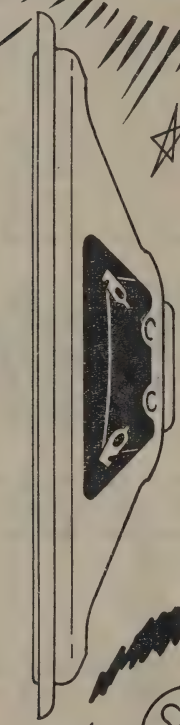
Green & Cooper, Ltd.,	J. B. MacEwan & Co., Ltd.,	R. H. Gardner,	Arnold & Wright, Ltd.
43 Lower Taranaki Street,	King Street,	42 Crawford Street,	126 Lichfield Street,
WELLINGTON	NEW PLYMOUTH	DUNEDIN	CHRISTCHURCH

Another ROLA FIRST

AN INVERTED ROLA SPEAKER

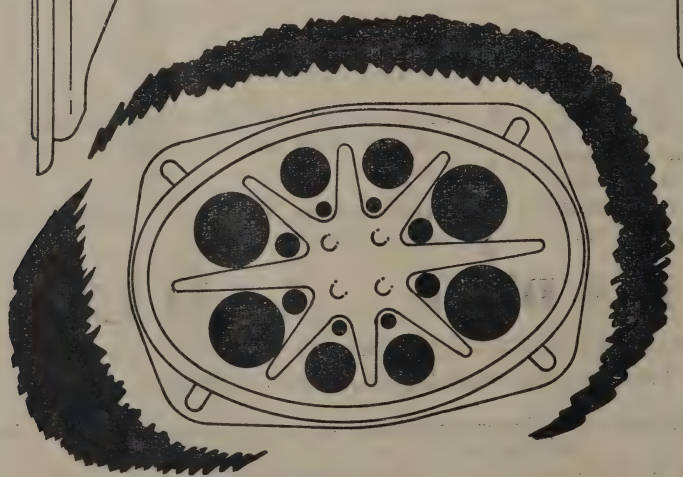


Designers of mantel and portable receivers will acclaim this new super-compact Model 9-6H Rola, Australia's first inverted elliptical loudspeaker.

Features of its design are a newly developed diaphragm assembly* and a driving system so placed that the overall depth of the speaker is only 2 inches.

This combination of elliptical design and inversion of the driving unit† provides a speaker which gives 8 inch results yet takes up little more frontal space than a 6 inch unit and is shallower than the standard 5 inch speaker.

** Patent No. 32306 applied for.*
† Rd. Design No. 27696.



NEW ZEALAND DISTRIBUTORS: *ORDER FROM DEALERS*

Swan Electric Co. Ltd.

Auckland • Wellington • Christchurch • Dunedin • Palmerston North

Measuring Insulation Resistance

(Continued from Page 20.)

.1 μf. condenser will have ten times the insulation resistance of a 1 μf. condenser of the same type. Consequently in order to compare the merits of condensers of different sizes, the insulation resistance is multiplied with the capacity. The insulation resistance is then expressed in megohm-microfarads; this quantity being the same for condensers of different sizes. A good condenser would have an insulation resistance of say 450 megohm-microfarads. This means that its resistance would be 450 megohms for a capacity of 1 μf., or 4500 megohms for a capacity of .1 μf.

Finally, the fact that a condenser has an insulation resistance which is low, is no definite indication that it cannot be used. It all depends in what circuit it is to be placed.

Amateur TV Project

(Continued from Page 28.)

procured our own multiplier photo-cells, and have built up a small two-stage pre-amplifier for a 931A, and it is with this that confirmation was made of the unsuitability of the green-screen P1 tubes. However, even with a short-persistence tube, it seems likely that a rather special video amplifier will be needed, with a response rising sharply at the high-frequency end of the video spectrum, so that as yet we will not describe this pre-amplifier unit, since it is likely to be considerably altered before being fit for actual picture-making.

Next month, therefore, it is proposed to describe a simpler deflection unit that will be more suitable for the VCR112 than the one already described. The latter was really designed with the VCR97 in view, and not the VCR112. The latter is not nearly so sensitive as the VCR97, and so requires much greater deflecting voltages to get the same amount of deflection. The new time-base unit will therefore have to include more amplification at least for the line time-base. Since this will necessitate more valves, it will probably be desirable to simplify the saw-tooth generator, if possible, so as not to bring the whole set-up up to an inordinate number of valves.

(To be continued.)

Miniature Three

(Continued on Page 33.)

taken all earths belonging to a single stage. This becomes progressively more important, the higher the operating frequency, and at very high frequencies should be made a major matter of policy.

The above points cover the main requirements for wiring any set, and are sound constructional principles, to be adhered to as far as possible. Sometimes they are mutually opposed, because it is clearly impossible to satisfy both (1) and (2) simultaneously, in that a miniature socket is a small affair, in which the grid and plate pins are actually close together, so that for at least some distance the grid and plate leads cannot be far apart. But here (3) comes to the rescue, for if opposite sides of the socket are shielded from each other then it clearly does not matter if the leads referred to are close together. The whole question is one which must be regarded with ordinary common sense, both when the lay-out of the chassis is being decided, and also in actually performing the wiring. If the chassis is badly laid out, it may be impossible to obey the rules of wiring set out above, and the art of laying out a chassis is simply that of arranging things so that the wiring *can* be done in accordance with the rules, while retaining, say good accessibility and appearance, to mention only two things.

In the next and final instalment of this article, the construction of the coils will be described in detail, and for the beginner, hints will be given on the operation of regenerative sets, that will apply not only to this one, but to any of the type.

(To be Continued.)

New Products

(Continued from Page 38)

skill in both fundamentals and details. The foregoing make this an ideal unit for sound film applications.

T-25 SUPER SILENT TURNTABLE

A professional type turntable for amateur use, available with or without pick-up. The T-25 will rotate at constant speed. As a result, the "wow," "flutter" and "rumble" so often found in ordinary turntables have been completely eliminated. The wide margin of reserve power of the motor, and the inertia of the cast turntable overcome the common tendency to slow down on the heavier passages and more violent transients. The motor, mounted on floating buffers, is synchronous and gives constant correct speed, at either 78 or 33⅓ r.p.m.

* * *

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Our stocks have been exhausted but further supplies will be coming to hand in May. We very much regret to advise subscribers that printer's charges for further supplies have so risen that we have to raise our prices too, but so as to keep the cost of single binders within reason we have been forced to discontinue discounts on quantity copies.

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ER50/F18

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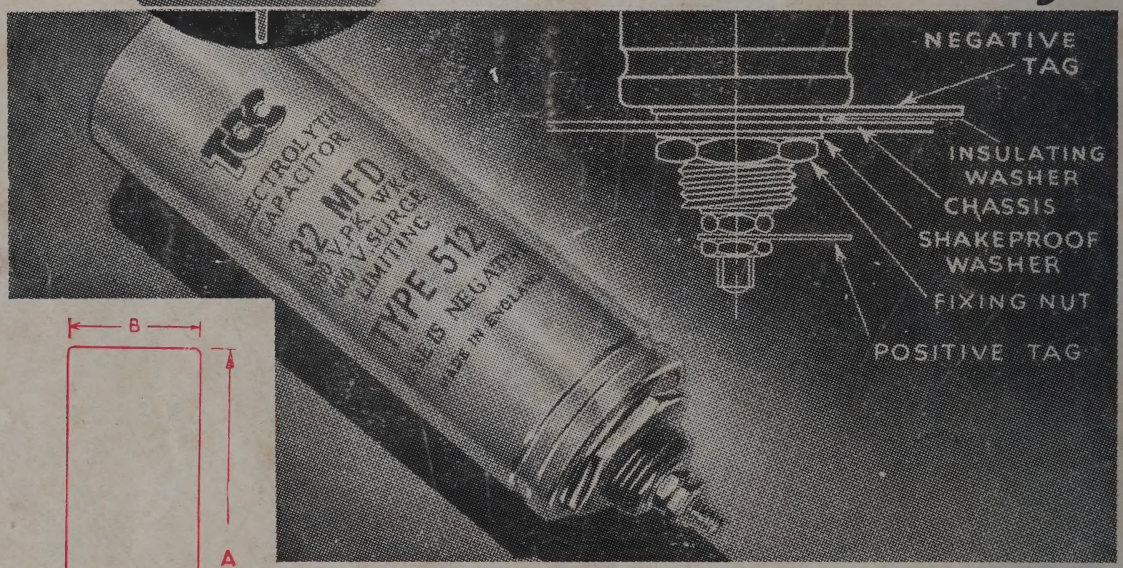

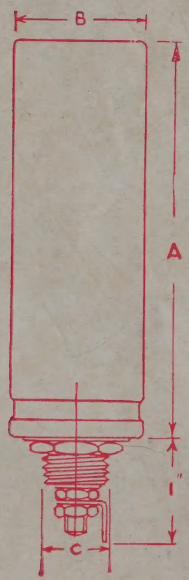

Capacitance in Mfds.	Peak Working Volts	Surge Volts	Dimensions in inches A	B	C	Type Number
*32	350	400	$2\frac{7}{8}$	1	$\frac{1}{2}$	312
4	500	600	$2\frac{7}{8}$	1	$\frac{1}{2}$	512
8	500	600	$4\frac{1}{2}$	1	$\frac{1}{2}$	512
16	500	600	$4\frac{1}{2}$	$1\frac{1}{2}$	$\frac{3}{4}$	512
32	500	600	$4\frac{1}{2}$	$1\frac{1}{2}$	$\frac{3}{4}$	512
8	600	700	$4\frac{1}{2}$	$1\frac{1}{2}$	$\frac{3}{4}$	922

This condenser has a screwed boss for one-hole chassis mounting. The can is negative, and this connection is to be made by contact with the chassis. Where it is desired to insulate the condenser from the chassis, an insulating washer and tag can be supplied for the negative connection as illustrated. The condenser is of all-aluminium construction with plain foil electrodes except where starred (*).

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